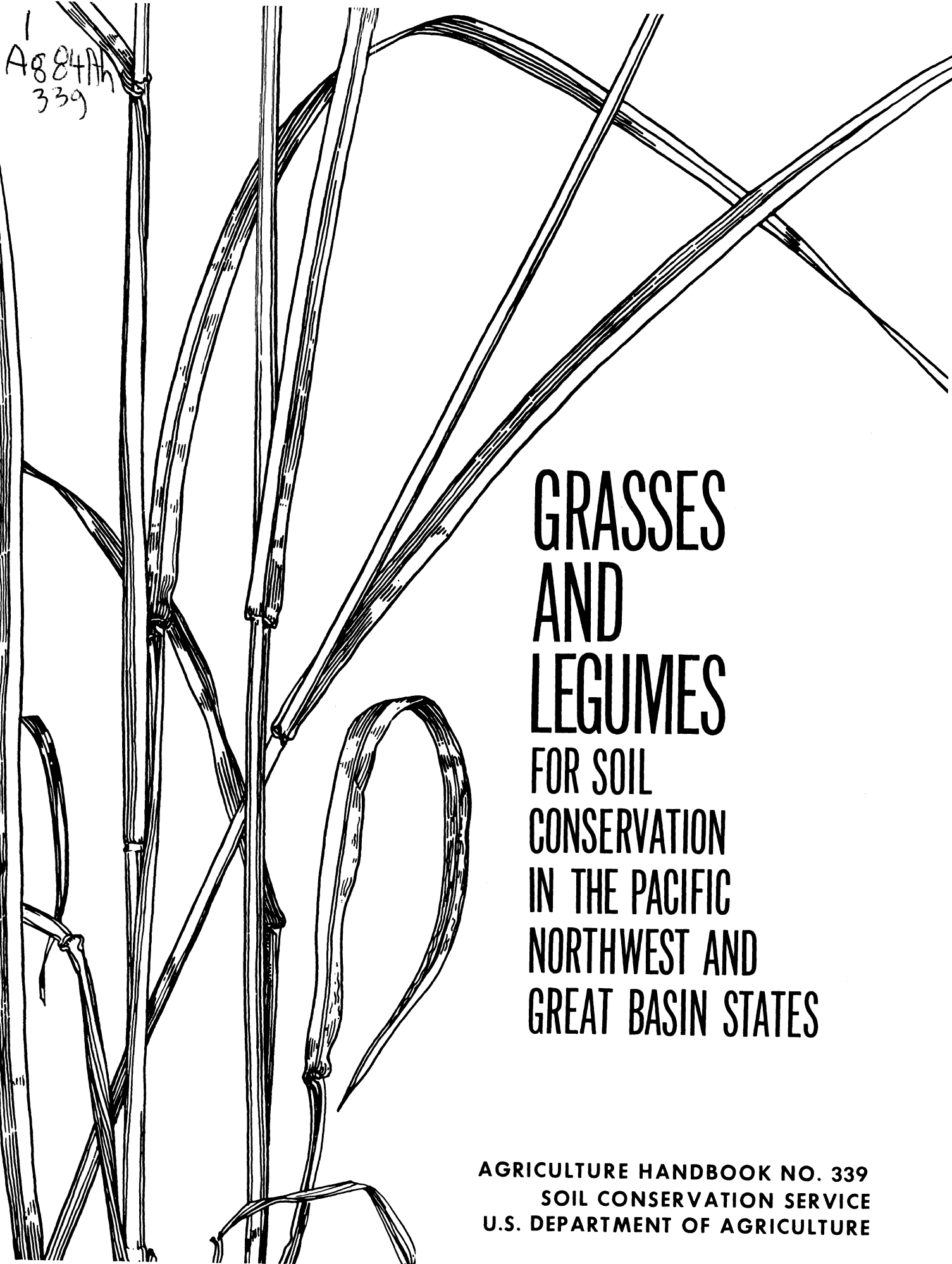




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GRASSES AND LEGUMES FOR SOIL CONSERVATION IN THE PACIFIC NORTHWEST AND GREAT BASIN STATES

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Grasses and Legumes for Soil Conservation in the Pacific Northwest and Great Basin States

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Introduction

This publication summarizes 32 years of systematic testing of grasses and legumes for conservation in the Intermountain West and adjacent areas of the North Pacific Coast and Great Basin. Intensive work on adaptation, cultural requirements, and management methods was done in Soil Conservation Service (SCS) plant materials centers in cooperation with the State agricultural experiment stations. Promising plants and cultural and management methods were then tested on farms and ranches in soil conservation districts.

When soil conservation began to be emphasized in the 1930's, adapted grasses and legumes were lacking for some of the jobs to be done. More and better planting materials of the few kinds in common use were needed by farmers and ranchers who began applying conservation treatment to their land. It was early apparent that the problem of planting materials would need special attention if grassland agriculture was to play its proper role in soil and water conservation.

In a widely cooperative program, plant materials centers were established by the Soil Conservation Service (SCS) and soon were engaged in the study and development of grasses and legumes for use in conservation work. The principal testing that formed the basis for this publication was conducted on the SCS plant materials centers at Aberdeen, Idaho; Corvallis, Oreg.; Pleasanton, Calif.; Pullman, Wash.; and the former center at Bellingham, Wash. ARS Plant Introduction Station supplied many of the plant introductions. The work was done in cooperation with the agricultural experiment station staffs in California, Idaho, Nevada, Oregon, Washington, and Utah.

SCS plant materials centers have three functions: (1) To assemble, evaluate, select, and increase grasses and legumes for use in soil and water conservation; (2) to determine reliable cultural and management methods for their use; and (3) to get proved materials into production by farmers, ranchers, and commercial growers.

More than 15,000 accessions of plants have been screened by the five plant materials centers serving this area. The system used by the centers consists of five steps: (1) Grasses and legumes that may have value for one or more soil and water conservation jobs are gathered from many sources and carefully compared to find superior material; (2) promising material is increased, either for more precise comparison or for study of cultural methods; (3) the best material is tested in outlying locations called field-evaluation plantings that represent soil and climatic conditions not found at the center; (4) seed is distributed to soil conservation districts for planting on farms or ranches where performance under actual use can be studied; and (5) seed or plants are furnished to soil conservation districts which, in turn, select farmers to increase the material, preferably under certification. All these steps are taken in cooperation with State and Federal experiment stations

and private research agencies who help insure that the highest standards are maintained in the work.

The materials come from four sources: Foreign plant introduction, collection of superior material from the native grasslands, collection of naturalized alien grasses and legumes of unknown origin that have survived in out-of-the-way places, and **strains from plant breeders**.

The mass of material that is collected for comparative evaluation must be tested rapidly yet objectively for the jobs required in conservation work. Samples are sorted into "use groups," each of which has a commonly known grass or legume to which the others can be compared. The use groups are based on the conservation job each grass or legume may do on farm, ranch, or watershed land. The comparisons are usually made in **rod-row** plantings at a plant materials center. Records are made of the important features of promising plants, such as seedling vigor, outstanding vegetative quality, freedom from diseases and insects, absence of weedy possibilities, ground-cover value, drought and winter hardiness, and yield of forage and seed.

The conservation-use-group concept is used in the organization and presentation in this handbook.

Many of the plants listed have been named and released cooperatively with State agricultural experiment stations. They have moved into commercial seed production and their use represents important economic and conservation contributions. Plants named, released, and introduced to commercial use as a result of work by SCS plant materials centers are shown in **boldface type**.

A list of references is appended. There are also many other publications that present data on the improved strains, cultural trials, seed production, performance, and use of the grasses and legumes mentioned in this handbook.

The maps in the center of this handbook show agricultural zones useful in determining plant adaptation and use. The zonation is based on the interrelations of soil, elevation, rainfall, length of growing season, and other factors that affect adaptation, growth, and use of **grasses** and legumes for soil and water conservation. It represents the composite knowledge of Soil Conservation Service soil scientists and plant scientists and their colleagues in State experiment stations and Federal agencies.

References to soil are based on "Soils of the Western States," which was compiled by the Western Regional Soil Survey Work Group of the Western Soil and Water Research Committee. The terminology of the Soil Survey Manual, U.S. Department of Agriculture Handbook 18, is used in describing soil factors affecting plant adaptation, such as texture and soil reaction. Plant adaptation and use is specified by great soil groups. Typical soil series are given for most of the groups. With this soil information the reader can relate plant adaptation and use to other soil classifications.

Conservation Use Groups

Group I. Rapid-Developing, Short-Lived Grasses

The grasses in group I have strong seedlings and reach full production in the second growing season. With one exception, these grasses have large seeds and produce good seed yields. They have several uses in conservation work. Most of them depend on natural reseeding for longevity.

GRASSES OF PRIMARY IMPORTANCE

COMMON RYEGRASS, *Lolium* spp., while predominantly Italian (annual) ryegrass, *L. multiflorum* Lam., usually is a mixture containing some perennial ryegrass and hybrids. Its especially strong seedling vigor is an advantage for some conservation uses but a disadvantage for others.

Common ryegrass is adapted to a wide range of soil and drainage conditions in zones V-1 to V-4 and H-1 to H-6. It can be used on any soil except those that are excessively drained or very poorly drained, provided MAP (mean annual precipitation) is 18 inches or more.

The greatest conservation use of common ryegrass is to provide a quick and effective ground cover for temporary stabilization of earth structures such as dams and dikes, grass waterways, and flood channels; for winter cover cropping; and for erosion control on cropland subject to overflow. When seeded in the early fall and fertilized with nitrogen, common ryegrass quickly provides a soil-stabilizing ground cover. It is sometimes used with red and alsike clovers and sweetclover for green manure in short crop rotations. Common ryegrass should never be seeded with long-lived grasses and legumes for forage production because it is too aggressive and actually reduces the stand of the slower and desirable components.

Common ryegrass produces as much as 1,800 pounds of seed per acre when fertilized with 20 pounds of nitrogen in the fall and 60 to 80 pounds in the spring. Most of the domestically grown seed is produced in zones V-1 and V-4 on moderately fine textured Planosols and Humic Gley soils. Typical series are Dayton and Wapato, respectively. About 100,000 acres are harvested for seed annually. Sheep often graze the fields in late winter and early spring.

PERENNIAL RYEGRASS, *Lolium perenne* L., a short-lived perennial, has the same wide range of adaptation as common ryegrass. Though slightly slower in becoming established, fully developed stands equal common ryegrass in production and are more persistent.

Perennial ryegrass is well suited for use with subterranean clover for sheep pasture on Reddish-Brown Lateritic and Gray-Brown Podzolic soils in zones H-2 and H-5. Typical series are Peavine and Laughlin, respectively. Pastures on these soils are grazed in late winter and early spring when soil moisture is adequate for plant growth. The plants are dormant in the summer when soil moisture is low.

Perennial ryegrass-red clover mixtures are used in rotation with strawberries, nursery stock, and vegetables. The grass-legume mixture usually remains on the land for 3 years and provides soil improvement, sanitation, and silage and hay crops.

When perennial ryegrass is added to long-lived grass-legume mixtures used for forage, care must be taken to keep the percentage of ryegrass in the mixture below 25 percent. More than this reduces the amount of both the more desirable long-lived grass and the legume.

Nearly all of the domestic seed of perennial ryegrass is produced in the same zones as common ryegrass. About 45,000 acres harvested annually yield 1,000 to 1,200 pounds of seed per acre. The seed fields are often grazed with sheep in late winter and early spring. The crop is harvested by windrowing and combining. After harvest, the residues are burned to control blind-seed disease (*Phialea temulenta*), to which perennial ryegrass is susceptible.

SLENDER WHEATGRASS, *Agropyron trachycaulum* (Link) Malte, is a domesticated native bunch grass with wide adaptation to soils and climate (Plate 1A). It is used primarily on medium-textured, deep, and well-drained Chestnut, Chernozem, and Prairie soils. Typical soil series are Walla Walla and Tetonia, Athena, and Palouse, respectively. In areas where these soils occur MAP is 12 to 18 inches. Slender wheatgrass is also adapted to irrigated Solonchak soils where $EC_e \times 10^3$ is 12-15. A typical series is Stanfield.

Slender wheatgrass was not used on farms in the Pacific Northwest until a variety adapted to the climate was found. From 104 collections one was chosen that is early in spring recovery, has a growth rate similar to sweetclover and red clover, is productive, has a high seed yield, and is resistant to stem rust, stripe rust, and head smut. This selection was called 'Primar' and registered in 1950. Seed is grown under certification.

The principal use of Primar slender wheatgrass is in mixtures with sweetclover for green manure in short crop rotations in zones D-3, D-4, R-4, and R-5. When grass and sweetclover are planted in alternate rows, root growth of the mixture is twice that of sweetclover grown alone. Primar slender wheatgrass is planted alone in zones of adaptation on land put into conservation reserve, on watersheds, and on highway fills. When planted alone it is moderately long-lived.

Primar slender wheatgrass produces an average of 500 pounds of seed per acre for three crops in solid seedings when fertilized annually with 60 pounds of nitrogen. It averages 800 pounds of seed per acre for five crops from cultivated rows on irrigated land. It is self-fertile. The crop can be combined, and the seed is easy to handle. The seed retains a viability of more than 70 percent for 6 years in warehouse storage in cool, dry climates.

BEARDED WHEATGRASS, *Agropyron subsecundum* (Link) Hitchc., is a native grass similar to slender



Plate IA.
Slender wheatgrass,
Primar.
Plant $\times 2/5$;
ligule $\times 8 1/2$;
spikelet, floret $\times 4 1/3$.

wheatgrass but is more robust and longer lived, although not as leafy. Seedling vigor is excellent, and seed is usually produced the first year.

Bearded wheatgrass also has wide adaptation to soils but is used primarily on Chestnut and Chernozem soils. Its use is the same as Primar slender wheatgrass. Comparisons between the two grasses in mixtures with sweetclover show that the percentage of bearded wheatgrass is higher.

Bearded wheatgrass is a variable species. An ecotype, assigned accession number P-9115, was selected from 36 accessions collected from the native vegetation. It is tall, broad leaved, resistant to stripe rust, and strongly self-fertile. It produces slightly more seed than Primar slender wheatgrass. The crop is grown and handled in

the same manner, except that bearded wheatgrass seed must be processed to remove the short, straight awns.

BLUE WILDRYE, *Elymus glaucus* Buckl., is used in conservation work as a permanent grass cover in wind-breaks, woodlots, and plantings of shrubs for wildlife cover and food (Plate IB). This grass is unique because it is compatible with the woody plants, its cover reduces the need for cultivating the plantings, and it does not compete with seedling trees. It is used this way on Chernozem and Prairie soils. Typical series are Athena and Palouse, respectively. Blue wildrye provides a quick and effective ground cover on Brown Forest soils, Reddish-Brown Lateritic soils, and Sols Bruns Acides when seeded in the ashes on burned-over timberland. Typical



Plate IB.
Blue wildrye,
P-2662.
Plant $\times 2/5$;
ligule $\times 2\frac{1}{2}$;
spikelet, floret $\times 1\frac{1}{4}$.

series are Springdale, Josephine, and Astoria, respectively.

There are many forms of blue wildrye, but of the 260 accessions tested 2 are in use. Both are tall, erect, and leafy and produce good seed crops. One of them, P-2662, is used in zones C-1 to C-4, D-3, and D-4 and the other, P-7137, in zones H-1 and H-2. Each is susceptible to stripe rust if grown in zones where the other is adapted.

Blue wildrye is self-fertile and produces 300 to 400 pounds of seed per acre. The seed must be processed to remove the slender awns. The seed retains a viability above 70 percent for only 2 to 4 years in warehouse storage.

GRASSES OF SECONDARY IMPORTANCE

'BROMAR' MOUNTAIN BROME, *Bromus marginatus* Nees., is a registered variety chosen from 154 accessions collected from native vegetation in the Pacific Northwest (Plate IC). Its primary use in conservation work is in mixtures with sweetclover in short crop rotations on Chernozem, Prairie, and Brown Forest soils in zones D-1, D-3, D-4, and C-1. These mixtures are often moderately grazed before being plowed for green manure. The grass is high in crude protein and digestible carbohydrates. Daily gains of 1.58 pounds were obtained when Bromar-sweetclover mixtures were grazed with beef cattle. When the mixture was plowed, 1.25 tons



Plate IC.
Mountain brome,
Bromar.
Plant $\times 2/5$;
ligule, spikelet,
floret $\times 3\frac{1}{2}$.

of roots per acre in the upper 8 inches were obtained—twice that from sweetclover grown alone.

Bromar produces an average of 1,000 pounds of seed per acre. The variety is easy to maintain because it is self-fertile. Since the seed shatters, care must be taken when harvesting. It is processed to remove the awns. The seed retains a viability of 70 percent for only 3 years in warehouse storage. Seed must be treated with a fungicide before planting because this grass is susceptible to head smut.

Use of Bromar mountain brome has declined rapidly since annual cropping with fertilizers has replaced crop rotations. Bromar can be used to stabilize road cuts and fills in National and State parks and similar areas where native vegetation is desirable.

TALL OATGRASS, *Arrhenatherum elatius* (L.) Presl., is adapted to many well-drained soils in the subhumid areas. Tall oatgrass is a useful conservation grass. It is easily established, shade tolerant, adapted to somewhat excessively drained and low-fertility soils, and compatible with legumes. Consequently, it is suitable for seeding burned-over timberland, skid roads, and trails and for use with alfalfa for silage and hay, especially on coarse-textured soils. Because of its erect growth and high palatability, tall oatgrass does not persist in pastures except when they are carefully grazed.

Tall oatgrass seed is more expensive than other adapted, improved species, thus limiting its use in conservation work. Harvesting is difficult because the seed tends to shatter before fully mature. An improved va-

riety, 'Tualatin'—later maturing, leafier, and finer stemmed than common tall oatgrass—was selected primarily because of greater resistance to seed shattering. However, even Tualatin seed-shattering losses are high if the crop ripens adequately to permit direct combining. Higher seed yields are obtainable by binding, but this method is more costly. The seed is light, fluffy, and short awned and must be processed for seeding with mechanical seeders. Dust from harvesting and processing is especially irritating. These production and processing problems contribute to the limited supply of tall oatgrass seed on the market.

OTHER RAPID-DEVELOPING, SHORT-LIVED GRASSES: **RESCUEGRASS**, *Bromus catharticus* Vahl., and **ALASKA BROME**, *B. sitchensis* Trin., are rapid-developing, high forage-producing, short-lived bunch grasses. Both are adapted to well-drained soils in zones H-1 to H-4 and V-1. They require fertile sites and are particularly dependent on nitrogen fertilizer for high production.

Several varieties of rescuegrass including 'Prairie,' 'Chapel Hill,' 'Nakara,' and 'Lamont' have been extensively tested in western Oregon and western Washington. Forage yields of rescuegrass varieties are impressive the first and second years after establishment but decline rapidly thereafter. Average production during a 4-year period is about equal to that of orchardgrass. Although of limited value in agricultural areas west of the Cascade Mountains, rescuegrass is useful for short-

term forage and green-manure crops.

Burlington brome, *B. sitchensis* Trin., is an ecotype of Alaska brome, collected near Burlington, Wash. In western Oregon and western Washington it almost equals perennial ryegrass in forage production but is leafier and matures later. Like rescuegrass, its use is limited, but it has value as a short-term forage and soil-improving crop.

Group II. Rapid-Developing, Long-Lived Grasses for Subhumid and Irrigated Areas

The grasses in group II combine ease of establishment, long life, and good seed production. They grow in the cool, wet weather of fall, spring, and early summer but do not endure drought.

GRASSES OF PRIMARY IMPORTANCE

ORCHARDGRASS, *Dactylis glomerata* L., has wide adaptation under subhumid or irrigated conditions but does best on medium-textured, well-drained, fertile, soils that are calcareous, neutral, or medium acid. An MAP of at least 18 inches or season-long irrigation water is required. Orchardgrass is used on many irrigated alluvial soils that are medium to moderately fine textured and medium acid to mildly alkaline.

Four general types of orchardgrass are recognized among the 200 accessions tested: tall, stemmy, early; tall, leafy, late; medium tall, leafy, medium late; and dwarf, medium late. All but the tall, leafy, late type



Figure 1—Alternate-row seeding of Latac orchardgrass and Du Puits alfalfa provides balanced feed for livestock.

ORE-75234



Plate IIA.
Orchardgrass,
Latar.
Plant $\times 2/5$;
ligule $\times 4\frac{3}{4}$;
spikelet, floret,
caryopsis $\times 7\frac{3}{4}$.

produce high yields of seed and it produces good yields. Much of the commercial seed is from the tall, stemmy, early type.

Root production from all types has been at least 5,000 pounds per acre in the upper 8 inches in four growing seasons. Orchardgrass produces a dense sod of medium-sized roots which have a beneficial effect on soil structure and make it especially useful in soil-conserving crop rotations.

Two varieties of orchardgrass are named and grown under certification for use in the West and a third is showing promise for special conservation purposes. Seed of at least three other named varieties is grown under certification for out-of-region use.

'Latar' orchardgrass (Plate IIA) is a selection from

the introduction P.I. 111,536. Two outstanding characteristics make it especially valuable as a hay and pasture plant. It is 10 percent higher in digestibility, and the daily intake by livestock is 14 percent greater than that of the common tall, stemmy, early varieties when cut and fed at the optimum hay stage. Latar is in the prebloom stage when the alfalfa is at the optimum growth stage for making hay. Therefore, the mixture makes high-quality hay. The other varieties of orchardgrass are too mature when the alfalfa is ready to cut, and a poor quality of hay results. Latar yields at least as much per acre as the early varieties.

Latar is also more compatible with legumes in pasture mixtures than are other orchardgrasses, especially in Latar-alfalfa mixtures, which required at least 30 days

regrowth between grazings. Latar-alfalfa pasture mixtures produce 1,000 pounds of beef or 15,000 pounds of milk per acre when irrigated and well managed.

Both 'New Zealand' white clover and Ladino clover are easier to establish with Latar than with other varieties of orchardgrass. When the early growth of either mixture is deferred for silage or hay, a higher percentage of legume is maintained than when other orchardgrasses are used.

'Akaroa' orchardgrass is medium, tall, leafy, and medium late. It is used primarily for pasture in zones H-1 to H-7, V-1, and V-3. Latar is gradually replacing Akaroa.

Mixtures of orchardgrass with alfalfa or birdsfoot trefoil for hay or with white clover for pasture in subhumid areas are planted in the spring on firm, weed-free seedbeds, preferably with a drill. Mixtures with alfalfa or Ladino clover on irrigated land at elevations below 4,000 feet are seeded in midsummer following harvest of an early maturing grain crop. Only orchardgrass and one legume should be used in the mixture. Alternate-row seedings of the grass and the legume are more productive from year to year than solid seedings (fig. 1). This practice insures that the desired balance will be maintained.

'Pomar' orchardgrass is a dwarf variety that makes an ideal cover crop for irrigated orchards, especially those on deep, moderately coarse textured, well-drained soils. Many orchards on such soils are on sloping land and cover crops are required to prevent erosion. Pomar orchardgrass, a selection from P.I. 111,537, was named and released in 1966. Its low growth reduces maintenance costs because less mowing is required, it does not interfere with short-rise sprinklers, and the residue disintegrates rapidly (fig. 2).

Orchardgrass is weakly self-fertile; therefore, when a variety is grown for seed—especially for certification—it must be isolated from other orchardgrass plantings and volunteer orchardgrasses. It is best to grow orchardgrass varieties in cultivated rows 24 to 30 inches apart in zones V-1 and V-2 and 36 inches apart under non-irrigated subhumid conditions in zones D-2, D-3, and D-4 and under irrigation. Seed production requires 20 to 40 pounds of nitrogen for establishment and 60 to

80 pounds annually thereafter. Yields of seed per acre depend on variety and seasonal conditions. Average seed production with Latar orchardgrass is 400 pounds per acre under nonirrigated conditions and 500 pounds under irrigation. Pomar orchardgrass produces 40 percent more than Latar. Orchardgrass seed retains a viability of more than 80 percent for 12 to 14 years under warehouse storage in cool, dry climates.

TALL FESCUE, *Festuca arundinacea* Schreb., is widely adapted to subhumid irrigated areas. It is unique among the grasses in group II because it yields well on poorly drained soils and on wet saline or saline-alkali soils and survives flooding in the winter. Tall fescue is useful in subhumid climates in zones V-1 to V-4 and H-1 to H-6 on Grumusols, Humic Gley soils, Planosols, and Reddish-Brown Lateritic soils. Typical series are, respectively, Climax, Cove, Dayton, and Peavine. On these soils and on poorly drained soils in zones D-3 and C-1 to C-4 tall fescue is substituted for the other grasses in group II. Tall fescue is used on soils in irrigated areas in zones I-2 to I-4 that are too alkaline or too wet for other grasses in this group. Tall fescue remains green during the summer months but continues to grow only when soil moisture is adequate.

The principal use of tall fescue is pasture for beef and dairy cattle. Grazing capacity of tall fescue pastures is high on fertile soil when moisture is adequate, but palatability and nutritive value are lower than for other grasses in group II. On deep, moderately well drained, medium-textured irrigated soil, tall fescue-alfalfa pastures produce about 10 percent less beef per acre than orchardgrass-alfalfa pastures. On fine-textured shallow soil under irrigation, tall fescue-Ladino clover pastures provide 15 percent more cow days of grazing per acre but slightly less milk and butterfat than orchardgrass-Ladino clover pastures.

Tall fescue has two features that make it useful in conservation work. It produces a large amount of coarse, tough roots and makes a good ground cover. In the upper 8 inches of Palouse silt loam, a deep Prairie soil, tall fescue produced more than 7,000 pounds of roots per acre in 6 years. Even when clipped at 3-week intervals, it produced 5,000 pounds of roots. These roots decrease soil density, improve soil structure, and prevent erosion. When planted alone and grazed or mowed, a dense stand of tall fescue will produce a turf that has high wearing ability. Good stands of tall fescue are often grazed with sheep in the wet winter months. In recent years tall fescue has been successfully used as a cover crop in established irrigated orchards where the shade is not too dense.

Three varieties of tall fescue are on the commercial market: 'Alta,' 'Kentucky 31,' and 'Goar.' Alta fescue is an ecotype from a planting first made in the Pacific Northwest in 1918 (Plate IIB). Kentucky 31 was collected from a field established in Kentucky in 1887. Since comparative tests between the two show no essential difference, Alta is the one used in the continental climatic area of the West. Goar was selected from a planting made in 1941 in the Imperial Valley of California. It is used where heat tolerance is a consideration.



Figure 2—Pomar, a dwarf orchardgrass, is ideal for an orchard cover crop.



Plate IIB.
Tall fescue,
Alta.
Plant $\times 2/5$;
ligule $\times 6\frac{1}{2}$;
spikelet $\times 4\frac{1}{3}$;
floret, caryopsis $\times 6\frac{1}{2}$.

Alta fescue is planted with Ladino clover in early spring as soon as a good, firm, weed-free seedbed can be prepared. No other grass should be added to the mixture because it will be grazed in preference to Alta fescue and a low-quality clumpy pasture will result. Alta fescue is planted alone for cover cropping; for stabilizing cuts or fills, dikes, and deep waterways; and on parking lots and playing fields. The planting is maintained with annual applications of 20 to 60 pounds of nitrogen.

Alta fescue produces an average of 500 pounds of seed per acre, but good stands that are well managed

may produce as much as 1,000 pounds. It produces best in cultivated rows spaced 36 inches apart in subhumid or irrigated areas and in solid stands or in 24-inch rows in zones H-2, H-4, V-1, V-2, and V-4. Nitrogen at the rate of 80 pounds per acre is required for good yields. Since seed of Alta fescue tends to shatter, swathing when the seed is in the hard-dough stage, followed by threshing with a pickup combine, is general practice. The seed is easy to clean, and seed in ordinary warehouse storage retains a viability of more than 70 percent for 8 to 10 years in cool, dry climates.



Plate IIC.
Smooth brome,
Manchar.
Plant $\times 2/5$;
ligule spikelet,
floret $\times 4\frac{1}{3}$.

SMOOTH BROME, *Bromus inermis* Leyss, is adapted to fertile, well-drained soils in the intermountain area of the West where MAP is at least 15 inches. Chernozem, Prairie, Brown Forest, and Brown Podzolic soils are best for this grass. Typical series are Athena and Lanark, Palouse, Springdale, and Helmer, respectively, common in zones D-1 to D-4, R-4, and R-5. Smooth brome is adapted to a wide variety of soils on irrigated land above 4,000 feet but not to soils that are more than mildly alkaline. These conditions occur in zones I-1, I-3, and I-5.

Smooth brome is a sod grass used with alfalfa for hay and pasture. It is noted for its palatability to all livestock. Yields of forage, roots, and seed are good. On Palouse silt loam the 4-year average yield of smooth

brome-alfalfa hay was 3.5 tons per acre, 27 percent of the hay was grass. In the same trial the mixture produced 3.38 tons of roots per acre in the upper 8 inches and 62 percent were grass roots. Good yields of forage and of roots and compatibility with alfalfa make smooth brome useful in rotations with cash crops for soil and water conservation.

Two principal types of smooth brome are recognized, northern and southern. The northern type is weakly rhizomatous, leaves are well up on the stem, and glumes are short. The southern type is strongly rhizomatous, leaves are near the base of the stem, and glumes are long. Notable differences are the earlier spring growth of the southern type and the more even growth of the northern type during the growing season.

'Manchar' smooth brome is a registered variety of the northern type developed by selection specifically for the West (Plate IIC). It was chosen for compatibility with alfalfa and for its leafiness, tendency to remain bunchy, strong seedling vigor, and the tendency of the seeds to thresh free from the chaff. Because it is slow to become sodbound, it maintains a desirable percentage of grass in mixtures with alfalfa for forage and for soil-improving crop rotations. The leaves are high on the stems, which is especially desirable when the mixture is used for hay. The seed heads are brown, and the dark purple seeds are heavy.

Manchar smooth brome-alfalfa mixtures are seeded in early spring on firm, weed-free seedbeds. Drilling in alternate rows is the preferred method of planting. Alfalfa is placed in the grass-seed attachment and smooth brome in the grain box. Alternate feed openings in the legume box are blocked. Or alternate rows can also be planted by putting dividers in the grain box of the drill and by mixing the two seeds separately with rice hulls. Manchar-alfalfa mixtures produce up to 3.5 tons of hay per acre on good soils in subhumid areas and up to 7 tons on irrigated land. The mixture produces more and better forage when annual applications of 60 pounds of P_2O_5 are made. On Brown Forest and Brown Podzolic soils, alfalfa declines. The grass that remains needs an annual application of 60 pounds of nitrogen.

Seed of Manchar smooth brome is grown on non-irrigated and irrigated land. On nonirrigated land seed crops are grown on Prairie and Chernozem soils in 12-inch rows. They are not cultivated, but weedicides are used. On Chestnut soils they are grown in cultivated 36-inch rows. On irrigated land the seed crop is grown in 36-inch rows and cultivated, and weedicides are used. With annual applications of 80 pounds of nitrogen, three or more seed crops can be taken from irrigated land or from nonirrigated Prairie and Chernozem soils. Only 40 pounds of nitrogen is used on non-irrigated Chestnut soils. The seed holds well and can be combined. Comparisons of combining, swathing, and binding and threshing show that at least 20 percent more clean seed is obtained when the crop is bound and threshed than when either of the other methods is used. The additional seed more than offsets the added cost for binding and threshing. Standing stubble after swathing or combine harvest and grass seed straw after threshing are highly prized for aftermath grazing or as winter feed for livestock.

Because smooth brome is weakly self-fertile, a variety such as Manchar grown for seed must be isolated from other smooth brome plantings when the crop is certified. Seed production averages 1,000 pounds per acre on irrigated land, 600 to 700 pounds per acre on Prairie and Chernozem soils, and 300 pounds per acre on nonirrigated Chestnut soils. Seed of Manchar retains a viability of more than 70 percent for 6 years when stored under cool dry conditions.

INTERMEDIATE WHEATGRASS, *Agropyron intermedium* (Host) Beauv., is adapted to well-drained soils in subhumid areas where MAP is at least 14 inches and to irrigated land that is not saline or alkaline.

Intermediate wheatgrass is best adapted to Prairie, Chernozem, Brown Podzolic, and the better Chestnut soils and to the Alluvial soils associated with them. Typical soil series are Palouse and Archabal; Athena and Lanark; Helmer; Walla Walla and Elmore; and Newberg. These soils are extensive in zones D-1 to D-4, C-1 to C-3, H-3, and H-6. On irrigated land in zones I-1, I-3, and I-5, intermediate wheatgrass is adapted to medium-textured, well-drained soil that is not more than mildly alkaline.

Intermediate wheatgrass is a mild sod former that is especially compatible with alfalfa for hay or pasture on nonirrigated land and on irrigated land that has a shortage of water. It is ideally suited for use with alfalfa for hay because it is not quite ready to flower when the alfalfa is ready to cut. For this reason the hay cut from the mixture is of excellent quality. Cutting the grass at this stage for several years has no adverse effect on the longevity of the stand. Average yields exceed 3.0 tons of hay per acre on moderately deep Prairie soils without irrigation.

Intermediate wheatgrass-alfalfa mixtures make good pasture, but they must be carefully grazed. This mixture produced 180 pounds of beef per acre on a good Prairie soil in a 51-day grazing season without feed supplements and without irrigation. On the same land intermediate wheatgrass produced 181 pounds of beef per acre when supplied with 60 pounds of nitrogen and 242 pounds of beef with 100 pounds of nitrogen. When grain was fed as a supplement for the next 70 days, another 210 pounds of beef was produced per acre. Pastures were grazed at moderate rates, and average daily gain was 2 pounds.

Root production in a 5-year-old stand of intermediate wheatgrass and alfalfa on a nonirrigated Prairie soil exceeds 11,000 pounds per acre in the upper 8 inches; 70 percent or more is provided by the grass. These grass roots greatly improve soil structure and resistance of the soil to erosion.

Intermediate wheatgrass is often substituted for smooth brome in conservation mixtures. It produces more forage in hay or pasture mixtures on irrigated land where there is a shortage of water. On nonirrigated land intermediate wheatgrass can be used on the better Chestnut soils where brome is either uncertain or short lived. Intermediate wheatgrass produces a better ground cover in the fall, winter, and spring than smooth brome because it does not freeze back with early frost.

Three principal types of intermediate wheatgrass were found among the 30 introduced accessions. One tall, broadleaved, blue-green, medium-late, mildly sod-forming type was selected from P.I. 98,568, named 'Greenar,' and registered (Plate IID). It is the variety on the market and most widely used in the West. Another type known as 'Amur' wheatgrass is taller, coarser, uniformly gray-green, develops more rapidly in the year of seeding, and is more aggressive than Greenar. But it is not as persistent or as high in quality. A third type is distinctly dwarf and shows promise for waterway seedings.

Greenar wheatgrass produces an average of 250 pounds of seed per acre for 3 years on nonirrigated land when planted in 36-inch rows, cultivated, and fertilized



Plate IID.
Intermediate wheatgrass,
Greenar.
Plant $\times 2/5$;
ligule, spike,
spikelet, floret $\times 5 1/4$.

with 60 to 80 pounds of nitrogen each fall. On irrigated land the seed yields average 500 pounds per acre. The stems are strong and resist lodging. Seed can be combined or swathed and combined. It threshes easily and is heavy and beardless. Cleaned seed retains a viability above 70 percent for 6 to 10 years when stored under warehouse conditions in cool, dry climates.

Special care must be taken to isolate **Greenar** seed-producing fields from other types of intermediate wheatgrass and from plantings of pubescent wheatgrass because they cross-pollinate easily.

GRASSES OF SECONDARY IMPORTANCE

RUSSIAN BROME, *Bromus tomentellus*, Boiss. is an introduced bunch grass adapted to Prairie and Brown

Forest soils. Typical soil series are Waha and Tolo, respectively. It is also adapted to well-drained mountain meadows that have acid soils. Its heavy growth of long, basal leaves makes a good ground cover. Leaves remain green most of the summer, even after seedstalks are mature. This grass is used for pasture and hay. It has a very low lignin content and high digestibility and the daily intake by sheep is high. Seed production averages 300 pounds per acre for two crops, but declines rapidly in subsequent crops.

MEADOW BROMES have potential as useful plants in soil conservation work. Twelve meadow brome accessions have been tested. All are similar. Precise identification, however, is difficult and seems to depend in part on chromosome numbers. The names *Bromus erectus*

Huds., *B. riparius* Rehm., and *B. biebersteinii* Roem and Schult. are given.

Spring recovery of the meadow bromes is rapid, yield of forage and seed is high, recovery after cutting or grazing is outstanding, and a large amount of roots persist after plowing. The plants are frost tolerant and palatable to livestock, even though they are sparsely pubescent. They are well adapted to Chernozem, Prairie, and Brown Forest soils in zones D-1 to D-3, C-1, and C-2. They are also adapted to slightly acid to mildly alkaline irrigated land above 3,000 feet in zones I-1 and I-2. Meadow bromes are compatible with alfalfa and with red and alsike clovers.

All accessions of meadow brome are slightly susceptible to head smut. Seed must be treated with a fungicide before planting.

A selection of *B. biebersteinii* from Turkey, P.I. 172-390, named 'Regar,' has been released, is in increase, and is being used in conservation plantings.

Group III. Saline- and Alkali-Tolerant Grasses

These grasses grow and produce feed on saline, saline-alkali, and alkali soils where other species are not adapted. They are coarse-leaved, moderately palatable grasses, and they produce high yields of forage. When planted in pure stands and fenced, these grasses are readily grazed by livestock.

TALL WHEATGRASS, *Agropyron elongatum* (Host.) Beauv., is a tall, vigorous, stemmy bunch grass with coarse, long, blue-green leaves and large seeds. It is much more palatable and nutritious than it looks. Laboratory and digestion trials show that tall wheatgrass, even in the early heading stage, is higher in digestible protein and in TDN (total digestible nutrients) than crested wheatgrass. Tall wheatgrass is the latest maturing grass adapted to the continental climatic areas of the West and also one of the most productive.

Tall wheatgrass is especially tolerant of saline and alkali soils. High yields of forage are obtained on irrigated or subirrigated saline soils and on imperfectly drained alkali soils, even at elevations to 7,500 feet. In a comparative test with tall fescue on subirrigated Humic Gley soil at Union, Oreg., it produced more than 7 tons of hay per acre. This was twice as much as tall fescue, and the tall wheatgrass remained green 30 days longer. The two hays were equally palatable to sheep. Although primarily a pasture grass for cattle, the coarse leaves of tall wheatgrass are readily eaten by sheep. Tall wheatgrass also makes good silage and is often cut and chopped for hay.

Tall wheatgrass is specifically adapted to Solonchak and Solonetz soils that occur most frequently as inclusions in the Sierozem, Brown, and Chestnut soils. They are often alluvial soils with high water tables to which evaporation has brought to the surface salts leached from adjacent higher areas. Sometimes saline conditions are aggravated when arid land is put under irrigation. Some of the soil series on which tall wheatgrass is the best adapted and the most productive grass are Ahtanum, Airport, Stanfield, and Umapine.

Forage yield could be increased 10 to 100 times by seeding tall wheatgrass on land now occupied by saltgrass and greasewood. On nonirrigated land MAP of at least 14 inches is needed and on irrigated land a minimum of 20 to 24 inches of water. Tall wheatgrass pastures are an asset in range areas in the intermountain zone because active growth of this grass into midsummer provides good pasture. This has been verified by research comparing tall wheatgrass with other dryland wheatgrasses in pastures grazed by cattle in August.

Tall wheatgrass is easily established with good cultural methods except where much salt or alkali is present, but several precautions are essential to good stands. The nature and concentration of the salts should be determined, the soluble salts should be leached out or flushed off, and existing competition—such as saltgrass—should be eliminated by plowing when the soil is dry. Drainage should be improved if possible.

Tall wheatgrass is usually seeded alone. Irrigated plantings may be made in the early spring and can be made between August 15 and September 15 at elevations below 4,000 feet. Where water is available, the land is preirrigated. A deep-furrow drill should be used for seeding to put the seed into moisture, and evaporation carries the salt concentration to the furrow ridges. Furrows are kept wet by light, frequent irrigations to keep the surface moist until the plants are established.

One full season's protection is required for establishing tall wheatgrass on irrigated land and two seasons under dryland. Letting the plants mature and set a seed crop the first year allows them to become well established. Stubble left at least 6 inches tall prevents close grazing during the following season. Spring grazing can begin when the ground is firm and there is at least 10 inches of new growth above the 6-inch stubble.

Beef cattle have gained 100 to 800 pounds per acre on tall wheatgrass pasture. The carrying capacity and



IDA-45358

Figure 3—Alkar tall wheatgrass produces 900 pounds of beef per acre on alkali soils.



Plate IIIA.
Tall wheatgrass,
Alkar.
Plant $\times 2/5$;
ligule $\times 4\frac{1}{3}$;
spike $\times 2/5$;
spikelet $\times 4\frac{1}{3}$;
floret $\times 2\frac{1}{2}$.

gains vary with location, soil, growing season, available moisture, fertilization, and grazing management. Sheep with lambs make good use of tall wheatgrass. The leaves are stripped from the stems, which are seldom eaten. Lambs marketed from tall wheatgrass pasture are equal in weight and quality to those pastured on other grasses (fig. 3).

For silage, tall wheatgrass is chopped between the heading and soft-dough stage. Yields range from 7 to 22 tons per acre green weight. The silage is nearly equal to corn silage in feeding value for cattle. When cut for hay at the heading stage, 10 to 12 percent protein is

present. The hay should be chopped before it is fed.

Tall wheatgrass is used in wildlife plantings where its tall, persistent, bunched growth provides nesting sites and cover for upland game birds. In wildlife plantings interrupted drill strips alternated with lower growing species provide excellent cover and good hunting.

Tall wheatgrass is an introduced species. It came from Turkey, other locations in Asia Minor, and the U.S.S.R. Some strains have green, bluish, or blue-green foliage. The most used variety 'Alkar' (Plate IIIA) has blue-green foliage. The blue color is intensified under droughty or strongly alkaline conditions. Alkar was de-

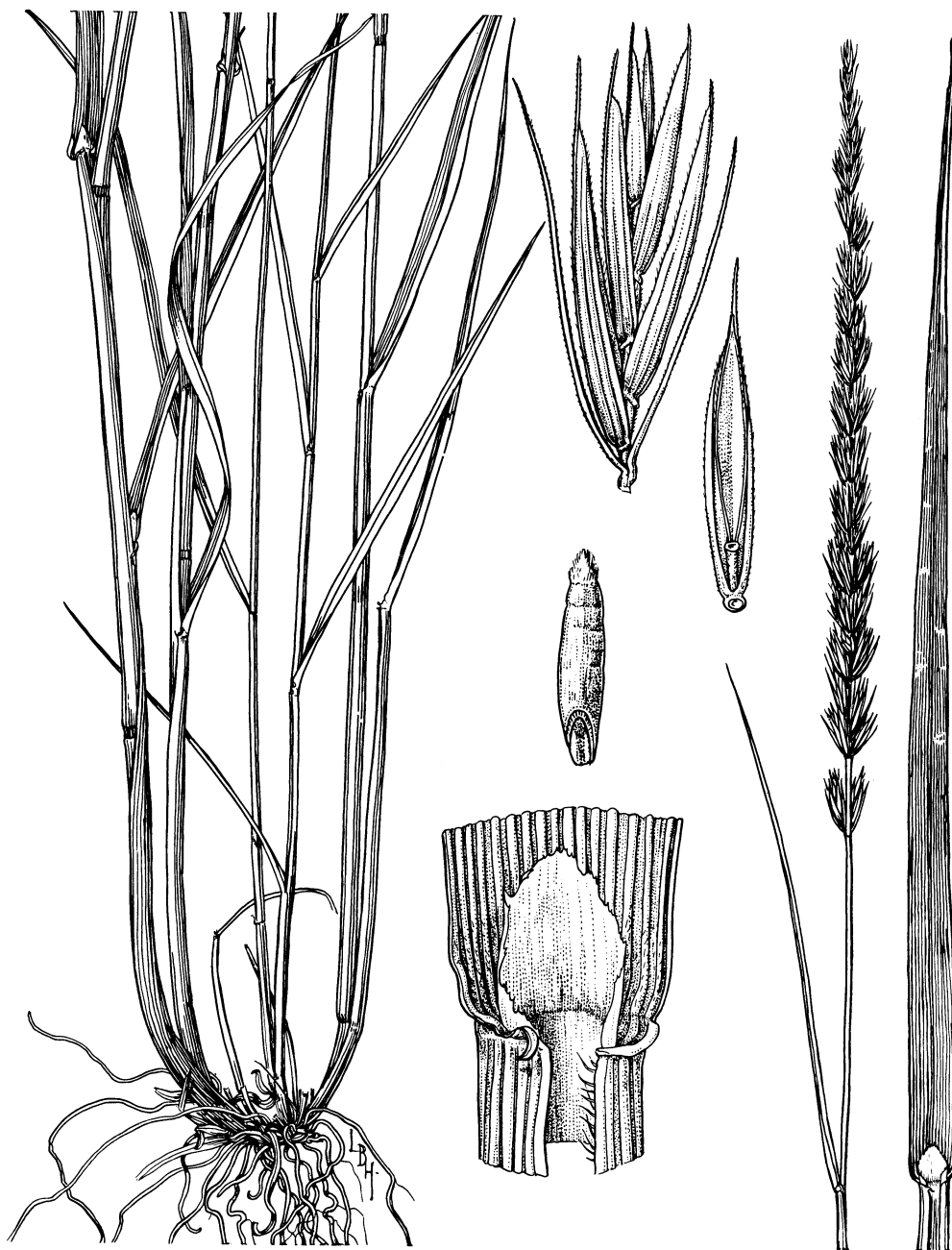


Plate IIIB.
Basin wildrye,
P-5797.
Plant $\times 2/5$;
ligule $\times 5 1/4$;
spike, leaf $\times 2/5$;
spikelet, floret,
caryopsis $\times 4 1/3$.

veloped at the Pullman, Wash., Plant Materials Center from P.I. 98,526.

Seed of Alkar tall wheatgrass is easy to grow at medium and low elevations where the growing season is long. Because of its late maturity, it requires season-long water on irrigated Alluvial soils or on deep nonirrigated Chernozem and Prairie soils with good moisture-holding capacity.

Seed is grown in 36-inch rows and cultivated, or in 12- or 14-inch noncultivated rows. Nitrogen at the rate of 60 to 80 pounds per acre is applied annually in the fall or early spring. With good culture, 300 to 500

pounds of clean seed is produced per acre. Seed is cut with a binder or windrowed and combined.

Alkar has a tremendous root system and produces a high tonnage of residue. It has been used to reclaim saline and alkali land for other crops. With proper culture, correct use of irrigation water, and drainage it has been possible to follow Alkar tall wheatgrass with alfalfa hay or other crops tolerant of moderately alkaline conditions.

BASIN WILDRYE, *Elymus cinereus*, Scrib. and Merr., is a native grass adapted to the same soils as tall wheatgrass. Because basin wildrye has early spring growth and



NEV-894

Figure 4—An excellent stand of basin wildrye on saline-alkali Humic Gley soil and with minimum irrigation water.

rapid fall recovery, it supplements tall wheatgrass in a pasture program on Solonetz and Solonchak soils. Established stands of basin wildrye survive longer periods of summer drought than tall wheatgrass. This is important where irrigation water is often not available in summer (fig. 4).

Basin wildrye is readily grazed by cattle and horses in early spring and early fall. Yields per acre are high if adequate moisture or irrigation water is available and nitrogen fertilizers are used. Animal gains are satisfactory. Grazing should begin when the new growth is 12 to 15 inches high. This usually occurs 3 weeks before tall wheatgrass reaches grazing readiness. Grazing in the early spring can be 80 percent if the livestock are removed while there is moisture in the soil. Fall grazing can begin at the same stage of readiness but 6 inches of stubble should be left. Sometimes the fall regrowth is not grazed, and the crop is used as standing hay in the winter.

Basin wildrye is established on irrigated land with the same careful cultural methods used for tall wheatgrass. On areas not irrigated but flooded by spring runoff, the seedbed is prepared in the fall and furrowed as for irrigation. The grass is planted in the furrows as early as possible in the spring.

Seed of basin wildrye is grown under irrigation, and an average annual yield for four crops is 250 pounds per acre. This yield is obtained with 80 pounds of nitrogen per acre applied in the fall.

Basin wildrye is widely distributed in the intermountain areas of the West; hence there are ecotypes that differ in growth form, coarseness, yield, and rate of germination. A selection, P-5797, germinates more readily and uniformly than other collections and is rated high in palatability trials using cattle (Plate IIIB). It was originally obtained from the University of Saskatchewan.

ALKALI SACATON, *Sporobolus airoides* (Torr.), is a coarse, tough, densely tufted perennial grass native to the West. More frequently found in the central and southern parts of the intermountain area, it grows on moderately fine textured saline, saline-alkali, and alkali soils. It is good forage for cattle and horses while it is growing vigorously. Fair quality hay can be made if cut at the bloom stage.

Alkali sacaton makes an excellent leafy ground cover on soils to which it is especially well adapted. It is especially useful where wind erosion occurs. It is used this way on land adjacent to airport runways. Once established, alkali sacaton requires minimum maintenance. A good seedbed, shallow seeding or broadcasting, and frequent irrigation are required to establish a good stand. After the establishment year, one irrigation of 3.5 acre-inches will maintain a good ground cover. This is an advantage where the supply of irrigation water is limited (fig. 5).



NEV-895

Figure 5—Alkali sacaton makes a good ground cover on saline-alkali soil with only one irrigation in a 5-inch rainfall area.

Established stands of alkali sacaton on moderately saline-alkali Humic Gley soil have produced 3.5 tons of forage with only four irrigations of 3.5 acre-inches and 120 pounds of nitrogen. The increment of forage per pound of nitrogen applied was 28 pounds, air-dry basis.

Alkali sacaton seed is collected from native stands when there is a good seed crop. Seed can be combined and is easy to clean. Seed retains its viability for many years in cool, dry storage.

OTHER SALINE- AND ALKALI-TOLERANT GRASSES:

Tall fescue, streambank wheatgrass, western wheatgrass, slender wheatgrass, and crested wheatgrass can be grown on some saline and alkali soils. Performance depends on the salts and on the amount of water that can be supplied. Sometimes drainage is a factor in selecting the grass. Tall fescue, either Alta or Goar, makes a satisfactory pasture when there is an ample supply of good-quality irrigation water and $EC_e \times 10^3$ does not exceed 12. Western wheatgrass tolerates an even higher salt concentration but is not a desirable cultivated forage. Streambank wheatgrass is primarily a ground-cover plant with a low water requirement. Crested wheatgrass grows on moderately alkaline soils under dryland conditions.

Group IV. Drought-Tolerant, Long-Lived Bunch Grasses

These drought-tolerant grasses are used chiefly in arid and semiarid areas for seeding rangeland in poor condition. On arable land where wheat-fallow farming is practiced they are used in long rotations or to divert land from grain production to grass. New seedlings develop slowly, but established stands are persistent and survive long periods of drought.

GRASSES OF PRIMARY IMPORTANCE

CRESTED WHEATGRASS, *Agropyron desertorum* (Fisch.) Schult., is used on Sierozem (Portneuf and Sagemoor), Brown (Ritzville), and Chestnut (Walla Walla) soils and the associated Regosols and Lithosols. All of them are moderately coarse or medium textured and have a minimum depth of 10 inches. The greatest use of crested wheatgrass is in zones R-1 to R-3, D-5 to D-7, and M-2.

Crested wheatgrass is used primarily to seed rangeland in poor condition or to convert marginal grainland to grass. It is usually planted alone and pastured. The pastures are fenced separately and grazed in the spring and again in the fall. Between these times the livestock graze the native ranges. If crested wheatgrass pastures are grazed season long, supplements are fed in late summer, fall, and winter. Occasionally crested wheatgrass is planted with alfalfa on eroded cropland in subhumid areas when the site is droughty. These plantings are pastured.

Crested wheatgrass is easy to establish, but the better the seedbed the more rapid the establishment. Drilling gives better stands than broadcast seeding. Deep-furrow drills give better and more consistent results than other types.

Seedlings are made in the fall on Sierozem soils and either in the fall or early spring on Brown and Chestnut soils. The latitude in time of seeding is greater as the preparation of seedbeds is intensified. Seeding in the spring is necessary on soils subject to frost heaving unless special cultural methods are used to minimize this damage.

Seedlings of crested wheatgrass develop slowly under arid and semiarid conditions. At least 2 years of complete protection are required before a planting can be safely grazed.

An established stand of crested wheatgrass will remain productive for 30 years if properly grazed. A successful method is to turn the stock into the pasture when spring growth is 6 inches tall, graze heavily, but remove the stock 30 days before the end of the growing season. When this is done, the pasture can be grazed again in the fall but a 4-inch stubble should be left to maintain plant vigor and protect the soil from erosion. Crested wheatgrass pastures will provide one-half to one animal-unit-month of feed per acre in semiarid areas when grazed in this manner, and beef cattle will gain 1 to 2 pounds per day.

A mixture of crested wheatgrass and 'Ladak' alfalfa is sometimes planted in cool, temperate, semiarid areas. These mixtures may produce slightly less hay per acre than alfalfa alone but more roots for soil protection and improvement. The mixture produced an average of 3,065 pounds of hay per acre and 6,530 pounds of roots in the upper 8 inches of soil in a 4-year test on Walla Walla silt loam (a Chestnut soil). Alfalfa alone produced 3,870 pounds of hay but only 4,310 pounds of roots. In the mixture the grass was 27 percent of the hay but 65 percent of the total weight of roots.

Crested wheatgrass produces good yields of seed, and the seed is easy to harvest. When grown in 36-inch rows, cultivated, and fertilized with 60 to 80 pounds of nitrogen, average annual seed production under irrigation is 800 pounds per acre for three crops. With the same treatment on Prairie soils in subhumid areas average production is 500 to 600 pounds of seed per acre. The seed holds well and can be combined. The hammermill can be used to break up spikelets, sometimes called "doubles." Crested wheatgrass, a tetraploid, is weakly self-fertile and the plants vary, but improved and named varieties are uniform. Crested wheatgrass seed will maintain a germination above 70 percent for 12 years when storage is dry and cool.

A total of 264 accessions of crested wheatgrass have been tested. They differ widely in vigor, leafiness, seed production, and resistance to leaf and stripe rusts. Most of the accessions are tall and stemmy. One type is dwarf and tends to be rhizomatous, but it develops slowly and yields are poor. Seed harvested from stands established on rangelands during the 1930's is often a mixture of crested wheatgrass and the closely related 'Fairway' variety (*A. cristatum*) L. Gaertn. The difference in the characteristics of these grasses is shown in Plate IVA. 'Nordan' is an improved variety of crested wheatgrass that was developed primarily for good seedling vigor. It is more uniform than other varieties; the heads are longer, nar-



Plate IV A.

I—Crested wheatgrass,
Nordan;

II—Siberian wheatgrass
P-27;

III—Crested wheatgrass,
Fairway.

Spikes $\times \frac{2}{3}$;
florets, caryopses $\times \frac{5}{4}$.

rower, and nearly awnless; and the leaves are broad, erect, and dark green.

SIBERIAN WHEATGRASS, *Agropyron sibiricum* (Willd.) Beauv., a selection from P.I. 108,434, is closely related to crested wheatgrass but differs from it in several important respects. It produces more feed in arid climates and on moderately coarse textured Sierozem, Brown, and Desert soils and the Lithosols and Regosols associated with them. Siberian wheatgrass consistently produced 11 percent more in an 8-year trial on Pancheri (Sierozem) soil.

Siberian wheatgrass often remains green 10 to 15 days longer than crested wheatgrass. The difference is more noticeable where late spring showers occur. In addition, Siberian wheatgrass has a lower lignin content than

crested wheatgrass: 7.5 percent as compared with 8.5 percent. This is important because the feed is 7 percent more digestible and the intake rate by livestock is greater. Sheep producers report that their livestock show a preference for Siberian wheatgrass.

In appearance Siberian wheatgrass differs from crested wheatgrass. Stems are finer, leaves are more lax, seed heads are narrower, and glumes are awnless (Plate IVB). Both grasses have the same cultural requirements.

Siberian wheatgrass produces 15 percent more seed per acre than crested wheatgrass on irrigated land. On non-irrigated Chernozem soils the 4-year average yield is 560 pounds per acre. This average on Chestnut soils is 448 pounds, while that for Nordan crested wheatgrass is 406 pounds. Seed of Siberian wheatgrass is grown under certification and is in good supply. Of the 12 introduc-



Plate IVB.
Siberian wheatgrass,
P-27.
Plant $\times \frac{2}{3}$;
ligule $\times 8\frac{1}{2}$.

tions tested, the selection given the number P-27 is the one grown commercially (fig. 6).

'WHITMAR' BEARDLESS WHEATGRASS, *Agropyron inerme* (Scribn. and Smith) Rydb., is an ecotype that was domesticated from the Palouse climax bunch grass prairie. Six ecotypes are recognized, and the accession named **Whitmar** is the best in the intermediate class. It has the widest adaptation to climate and soil. This variety has moderately abundant, erect to semierect small stems and abundant soft, flat, lax, narrow leaves. Seeds are typically awnless, but short straight awns occasionally occur.

Whitmar wheatgrass is adapted to the same soils and climate as crested wheatgrass. Under adverse climatic conditions it yields more feed and is more consistent in

production. This is especially true as the stands become older. Good stands on Brown soils (Ritzville) will provide one-half to one animal-unit-month of usable forage per acre.

Root production by **Whitmar** wheatgrass is high. At the end of six growing seasons on a Chestnut soil, the upper 8 inches of soil contained 11,000 pounds of roots and crowns per acre. Crested wheatgrass in the same test produced only 8,939 pounds. The roots of **Whitmar** are fine and produce a tough, persistent sod.

Good stands of **Whitmar** are obtained from early spring seedings on summer fallow land on Brown and Chestnut soils. If land preparation is less intensive or the plantings are on Sierozem soils, fall seedings are more successful. Deep-furrow drills are preferred to other types of seeders. The seed should be treated with an insecticide



IDA-45304

Figure 6—This field of certified Siberian wheatgrass produces 1,000 pounds of seed per acre, enough to reseed 200 acres of rangeland.

to prevent wireworm damage and with a fungicide to prevent infection from the soil-borne pathogen *Podospora verticillata*. The grass requires 3 years of protection before it can be grazed safely.

Whitmar wheatgrass must be carefully grazed to maintain good, vigorous growth. When seedlings are used to supplement crested wheatgrass on rangeland Whitmar is fenced separately. Grazing this grass with cattle in late spring, summer, and fall is the most common practice. A rotation-deferred system of grazing is the best practice, and two pastures of equal production are required. One of them may be native wheatgrass range. An ideal arrangement is to graze a crested wheatgrass or Siberian wheatgrass pasture for 6 weeks in the spring, the first Whitmar pasture for the next 10 weeks, and then the second Whitmar pasture for another 10 weeks. In succeeding years the grazing period of the two Whitmar pastures is alternated. Not more than 50 percent of the current year's growth of stems and leaves should be taken (fig. 7).

Even when well headed the coefficient of digestibility of Whitmar wheatgrass is higher than crested wheatgrass at a similar stage of maturity. Average gain by sheep in 10 days is 1.36 pounds. Whitmar, like many other native grasses, retains its nutrients better than introduced grasses and is sometimes used as standing hay during late fall and winter months. Whitmar is injured less by gophers than crested wheatgrass in seedlings on rangeland.

Seed of Whitmar is produced in 30- to 36-inch rows under irrigation and in 12- to 14-inch rows on deep Chernozem or Prairie soils. With these closely spaced rows weedcides are necessary and only two seed crops are taken, averaging 300 pounds per acre. When seed is produced in cultivated rows under irrigation and 60 to

80 pounds of nitrogen applied annually, production averages 384 pounds for 5 years.

Seed shatters readily. Either binding or swathing when the seed is in the soft-dough stage is better than combine harvest. Swathed stands are threshed with a pickup combine as soon as they are dry. Seed is easy to clean and does not require processing. Whitmar wheatgrass was registered in 1958 and seed is grown under certification. Germination remains above 70 percent for 6 years under cool, dry warehouse storage.

GRASSES OF SECONDARY IMPORTANCE

FAIRWAY CRESTED WHEATGRASS, *Agropyron cristatum* (L.) Gaertn., is a distinct species and is diploid ($2n = 14$). It has the same adaptation to climate and soils as standard crested wheatgrass. Fairway is weakly rhizomatous and is more uniform, shorter, leafier, finer stemmed, and earlier in maturity than the standard type. The seed heads are distinctly shorter, broader at the base, sharply tapered to the tip, and the awns are longer and more numerous (Plate IVA). Short hairs cover the upper side of the leaves.

Because Fairway crested wheatgrass reseeds, it is especially useful for stabilizing reservoir berms, waterways, and highway cuts and fills in cool, arid, and semiarid climates.

Fairway crested wheatgrass is a good seed producer. Average seed yield for three crops on Chestnut soil is



WN-90348

Figure 7—Whitmar wheatgrass seeded on submarginal wheatland provides summer feed for livestock.



Plate IVC.
Bluebunch wheatgrass,
P-739.
Plant $\times 2/5$;
ligule $\times 4\frac{1}{3}$;
spikelet, floret $\times 2\frac{1}{2}$.

375 pounds per acre. Seed crops are managed in the same way as those of standard crested wheatgrass. Only certified seed should be used in plantings. Cultural requirements are the same as those for standard crested wheatgrass.

BLUEBUNCH WHEATGRASS, *Agropyron spicatum* (Pursh) Scribn. and Smith, is more widely distributed in the native grasslands than beardless wheatgrass (*A. inerme*). Four ecotypes are recognized, and two have promise for domestication. One of them is tall, robust, mildly sod-forming, leafy, and has large awned seeds (Plate IVC). The other has finer stems, is a bunch grass, and has small awned seeds. The first is adapted to cool, subhumid areas on Chernozem and Brown Forest soils

and the second to cool, semiarid areas on Chestnut soils. Both are tetraploid ($2n = 28$), but neither is commercially available.

Bluebunch wheatgrass has the same cultural and management requirements as Whitmar beardless wheatgrass. Because the seeds are awned they must be processed before they can be easily cleaned or planted.

RUSSIAN WILDRYE, *Elymus junceus* Fisch., is unique among the grasses in this group because of its high digestibility and exceptionally long season of use. In comparison trials with sheep, Russian wildrye had a coefficient of digestibility of 60.2 percent and crested wheatgrass 45.1 percent. Although Russian wildrye begins growth early in the spring, it remains green and digestible much



Plate IVD.
Russian wildrye,
P-9012.
Plant, spike $\times 2/5$;
ligule $\times 8\frac{1}{2}$;
spikelet, floret $\times 3\frac{1}{2}$.

longer into the summer months. Growth and recovery after grazing are excellent, especially where some summer rains occur. For this reason its best use is for grazing in late summer and early fall when livestock lose weight on other grasses in semiarid areas. Russian wildrye is used in zones D-1, R-1, and R-5.

Russian wildrye was introduced from Siberia. It is a bunch grass with erect, naked seedstalks arising from an abundance of basal leaves (Plate IVD). Although it establishes slowly, it soon produces an immense mass of fibrous roots. Its yield of forage per acre is not as high as that of other grasses in the group, but high digestibility

and unique season of use are compensating factors for livestock pastures.

The principal deterrent to wider use of this grass is erratic seed yields. The 'Vinall' variety partially overcomes this deficiency and has averaged 280 pounds of seed per acre for 8 years at one location in the Great Plains.

HARDINGGRASS, *Phalaris tuberosa* var. *stenoptera* (Hack.) Hitchc., is a long-lived, winter-growing perennial bunch grass. It is well adapted as late-winter, spring, and early summer pasture in zones H-2, H-3, H-5, H-6,

and V-1 where MAP is 25 inches or more and MAT (mean annual temperature) is 50° to 55° F. Hardinggrass is well adapted to medium and moderately fine textured Planosols, Grumusols, Reddish-Brown Lateritic, and Noncalcic Brown soils. Typical series are Dayton, Climax, Nekia, and Laughlin, respectively. The grass is singularly adapted to and excellent in yield on Dayton soils.

Hardinggrass is one of the earliest grasses to reach grazing readiness in the winter and one of the last to go dormant under dryland conditions in the summer. It is about equal to Alta fescue in forage production but is much more palatable, particularly to sheep. It is compatible with subterranean clover (subclover) on well-drained upland soils and with white clover on soils too poorly drained for subterranean clover. Successful stands of hardinggrass are obtained from spring seeding, but seedlings are susceptible to winterkill when planted in the fall. Established stands respond with high increment of production to both spring and fall applications of nitrogen. On nonirrigated soils 30 pounds of nitrogen is applied in the fall and 30 pounds in the spring.

Group V. Drought-Tolerant, Long-Lived Sod Grasses

Drought-tolerant, long-lived sod grasses are unique in the intermountain zone where bunch grasses are the dominant vegetation. There are four grasses in group V; one is an introduction and the others are from the native prairies. All of them have large seeds and good seedling vigor, making them easy to establish.

PUBESCENT WHEATGRASS, *Agropyron trichophorum* (Link) Richt., a foreign plant introduction, is adapted to a wide range of precipitation, temperature, and elevation. Staying green into the summer months when soil moisture is adequate is an outstanding feature. Good stands of pubescent wheatgrass on rangeland retard invasion of sagebrush and rabbitbrush.

Pubescent wheatgrass is used primarily for permanent seedings on rangeland and for waterways on farmland. It is best adapted to Chestnut, Brown Forest, and the better Brown soils. Typical series are Walla Walla; Klicker; and Bancroft, Ritzville, and Haw. Regosols and Lithosols are associated with them. All of these soils are well drained and slightly acid, neutral, or mildly alkaline. MAP required for long life and good production depends on elevation. Below 3,500 feet, 12 inches is required; at higher elevations 10 inches is adequate.

Pubescent wheatgrass makes an ideal waterway in areas where Chestnut soils are dominant, even if the soil is shallow. These conditions are found in zones D-1, D-5, R-2, and R-3. Once established the seeding makes a complete cover, is remarkably persistent, and requires a minimum of maintenance.

On moderately coarse textured soils on rangeland where MAP is less than 12 inches the long-lived, drought-tolerant bunch grasses (group IV) are preferred to pubescent wheatgrass for pasture. Intermediate wheatgrass (group II) is preferred to pubescent when MAP is more than 15 inches. Comparisons between intermediate and pubescent wheatgrass on Chestnut and Brown soils show that

the latter is longer lived and maintains better and more uniform annual production.

Yields of forage by pubescent wheatgrass depend on total annual precipitation and the distribution of rainfall in summer. Comparisons of production by this grass and bunch grasses (group IV) on Brown soils in areas of 10 to 12 inches of precipitation show them to be equal, but with more moisture on Chestnut soils pubescent wheatgrass produces 30 to 50 percent more feed. Grazing capacities of 1 to 1.5 animal-unit months per acre are obtained on Chernozem soils with 15 to 18 inches of precipitation. Pubescent wheatgrass is higher than crested wheatgrass in TDN, lower in lignin content, and about equal in protein until it has flowered. Cattle use is about the same for both grasses in the spring but more for pubescent wheatgrass in early summer.

Pubescent wheatgrass can be planted in the fall or in early spring with equally good results when good seedbeds are prepared. Deep-furrow drills are preferred. The grass is planted alone on Brown soils but may be grown for forage in alternate rows with Ladak alfalfa on deep Chestnut soils.

No major differences were found among eight accessions that have been tested. A selection from P.I. 107,330 was named 'Topar' (Plate VA). It is registered, and seed is grown under certification. Yields of seed are best on medium-textured soils at elevations between 2,500 and 4,500 feet. When grown in 36-inch rows and cultivated, an average of 400 pounds of seed per acre can be obtained for 5 years when MAP is 16 to 20 inches or with irrigation. Annual applications of 60 to 80 pounds of nitrogen are required. Since seed does not shatter, the crop can be swathed and combined. It is difficult to thresh because the rachis breaks up and the seeds adhere to the segments. The minimum purity standard for certified seed should not be more than 90 percent because the rachis segments are difficult to remove when cleaning the seed. A selection from P.I. 107,328 has been named 'Luna' and was recently released by the Soil Conservation Service and the New Mexico Agricultural Experiment Station.

Pubescent wheatgrass is disease free but is subject to injury by Banks grass mite (*Oligonychus pratensis* Banks), especially in seed fields. Mites feed on the leaves until badly infested fields appear to be suffering from drought. Timely applications of dusting sulfur or other miticides have given effective control. Mite damage is usually not severe in grazed stands of pubescent wheatgrass.

Pacific grass bugs show a preference for pubescent wheatgrass. They feed on the chlorophyll in the leaves and leaf sheaths, giving the plants a whitish appearance. Infestations are seldom severe enough to justify control measures.

STREAMBANK WHEATGRASS, *Agropyron riparium* Scribn. and Smith, is a native sod grass, but its name does not suggest its use or adaptation. It is drought tolerant and the seed germinates quickly, even when rainfall is scanty. Streambank wheatgrass has strong rhizomes that enable the grass to spread rapidly to form a good ground cover.



Plate V A.
 Pubescent wheatgrass,
 Topar.
 Plant $\times \frac{2}{3}$;
 spike $\times \frac{2}{5}$;
 ligule $\times \frac{4}{3}$;
 spikelet, florets,
 rachis $\times \frac{3}{2}$.

At elevations less than 3,500 feet, minimum MAP for establishment and growth is 12 inches, but above this elevation is 9 inches.

Streambank wheatgrass is adapted best to Brown soils (Ritzville) and Chestnut soils (Bannock and Walla Walla). At elevations above 3,500 feet, this grass is used on Sierozems (Sagemoor and Portneuf). It is also adapted to moderately alkaline soils.

Streambank wheatgrass has special uses in soil and water conservation work. Since the plants are short, have narrow smooth leaves, and are not especially palatable to livestock, it is not a forage-producing grass. On irrigated soils, it is used for cover on the banks of canals, laterals, and farm ditches. Its dense, low-growing sod gives good protection to the soil and keeps out weeds.

Streambank wheatgrass is easily crowded out by other grasses if the site is wet. Little seed is produced from solid stands; so there is no danger of the grass spreading to irrigated cropland (fig. 8).

Under dryland conditions the main use of streambank wheatgrass is cover for highway shoulders, cuts and fills, borrow pits, and median separators. The short growth requires a minimum of maintenance and is not a fire hazard. Streambank wheatgrass because of its sodding characteristics and short growth is successfully used as a permanent and smooth cover on airports used by light aircraft and on large airports to stabilize soil adjacent to runways and near hangars. Under dryland conditions it makes a permanent lawn for homes and playgrounds and, when established, requires infrequent watering and



IDA-45356

Figure 8—Sodar wheatgrass completely stabilizes irrigation ditches, does not spread into the cultivated fields, and keeps out weeds.



IDA-45355

Figure 9—Sodar wheatgrass makes an ideal cover for small-plane airfields. It is a smooth cover, requires little maintenance, and controls weeds.



IDA-45353

Figure 10—Sodar wheatgrass provides erosion control when seeded on highway medians, cuts, and fills.

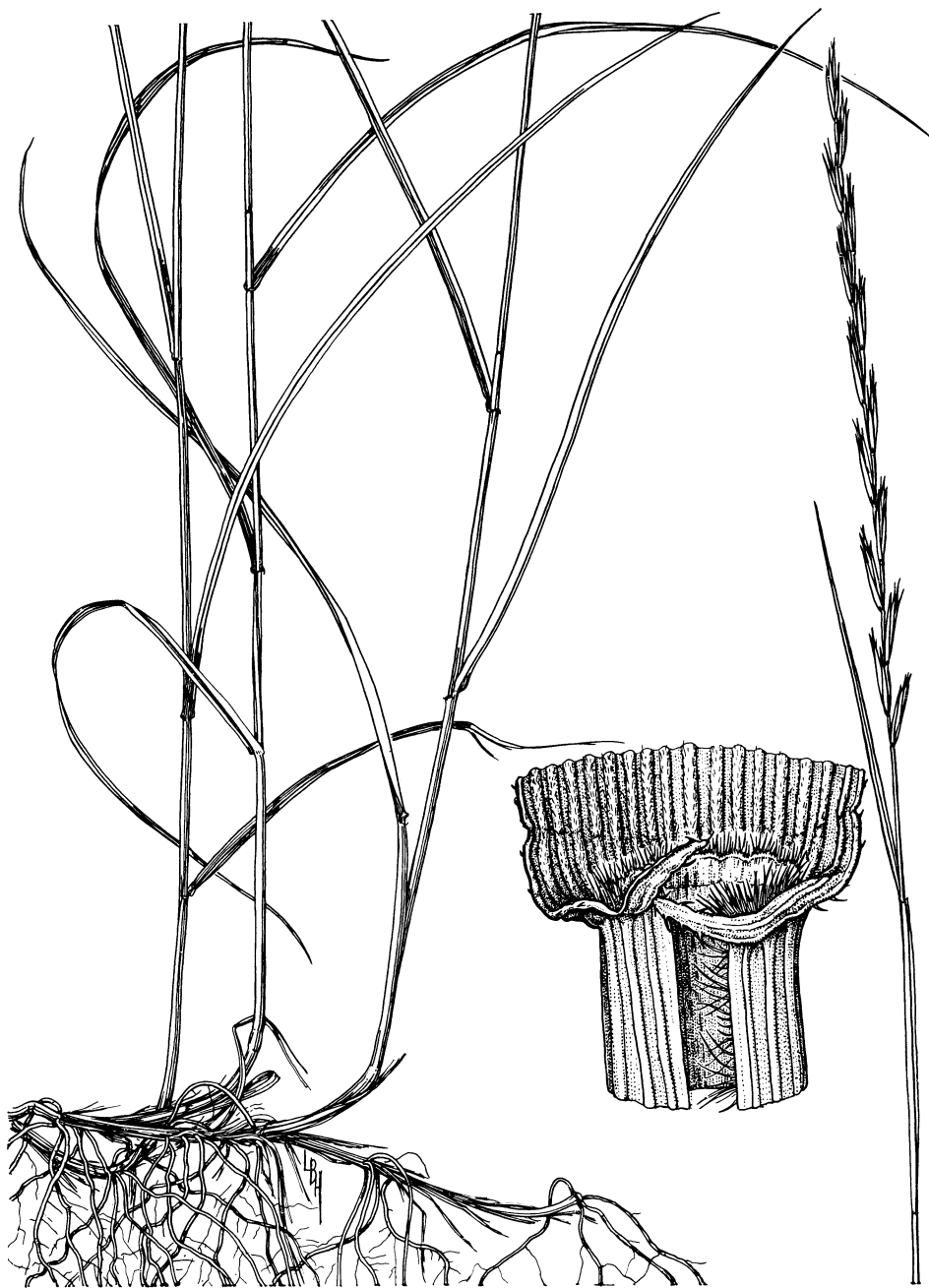


Plate VB.
Streambank wheatgrass,
Sodar.
Plant, spikelet $\times \frac{2}{3}$;
ligule $\times 8\frac{1}{2}$.

minimum maintenance. It can also be used for parking areas and in machinery yards (figs. 9 and 10).

Many accessions of streambank wheatgrass have been collected from the native vegetation and tested. They have no major differences but a composite of aggressive, leafy, low-growing plants resulted in a uniform variety that was named 'Sodar' and released in 1954. Seed is grown under certification (Plate VB). On irrigated land in 36-inch rows, the average yield of seed for two crops that receive 60 to 80 pounds of nitrogen is 500 pounds per acre. Experienced seed growers have averaged 900

pounds with 120 pounds of nitrogen on irrigated sandy soils.

THICKSPIKE WHEATGRASS, *Agropyron dasystachyum* (Hook.) Scribn., is the most widely distributed native sod grass in the northern part of the intermountain region. It is common in the upper Snake River basin and has been the major part of the ground cover on critical watersheds after they were protected against overuse. Once a flood hazard to municipal property, these watersheds no longer have excessive runoff and soil erosion



Plate VC.
Thickspike wheatgrass,
P-1822 (L);
Streambank wheatgrass,
Sodar (R).
Spikes $\times \frac{2}{3}$;
spikelets, florets $\times 3\frac{1}{2}$.

even from torrential rains.

Thickspike wheatgrass is closely related to western wheatgrass but is more drought tolerant. It produces good ground cover and satisfactory yields on moderately coarse textured Brown and Sierozem soils and the Regosols associated with them. These soils are often subject to wind erosion.

Thickspike wheatgrass is seeded alone on rangeland and is grazed in early summer after *Bromus tectorum* is mature and crested wheatgrass is fully headed and low in nutritive value.

The more than 50 collections of thickspike wheatgrass studied comparatively vary in leafiness, forage and seed yield, hairiness, and resistance to leaf and stripe rust. Average seed yield in 36-inch rows on Chernozem soils is 300 pounds for 3 years. Seed of thickspike wheatgrass holds well and may be combined. Seed is not yet commercially available.

Throughout the area of greatest natural distribution are many forms intermediate between thickspike and western wheatgrass and between thickspike and streambank wheatgrass. This suggests that these species may

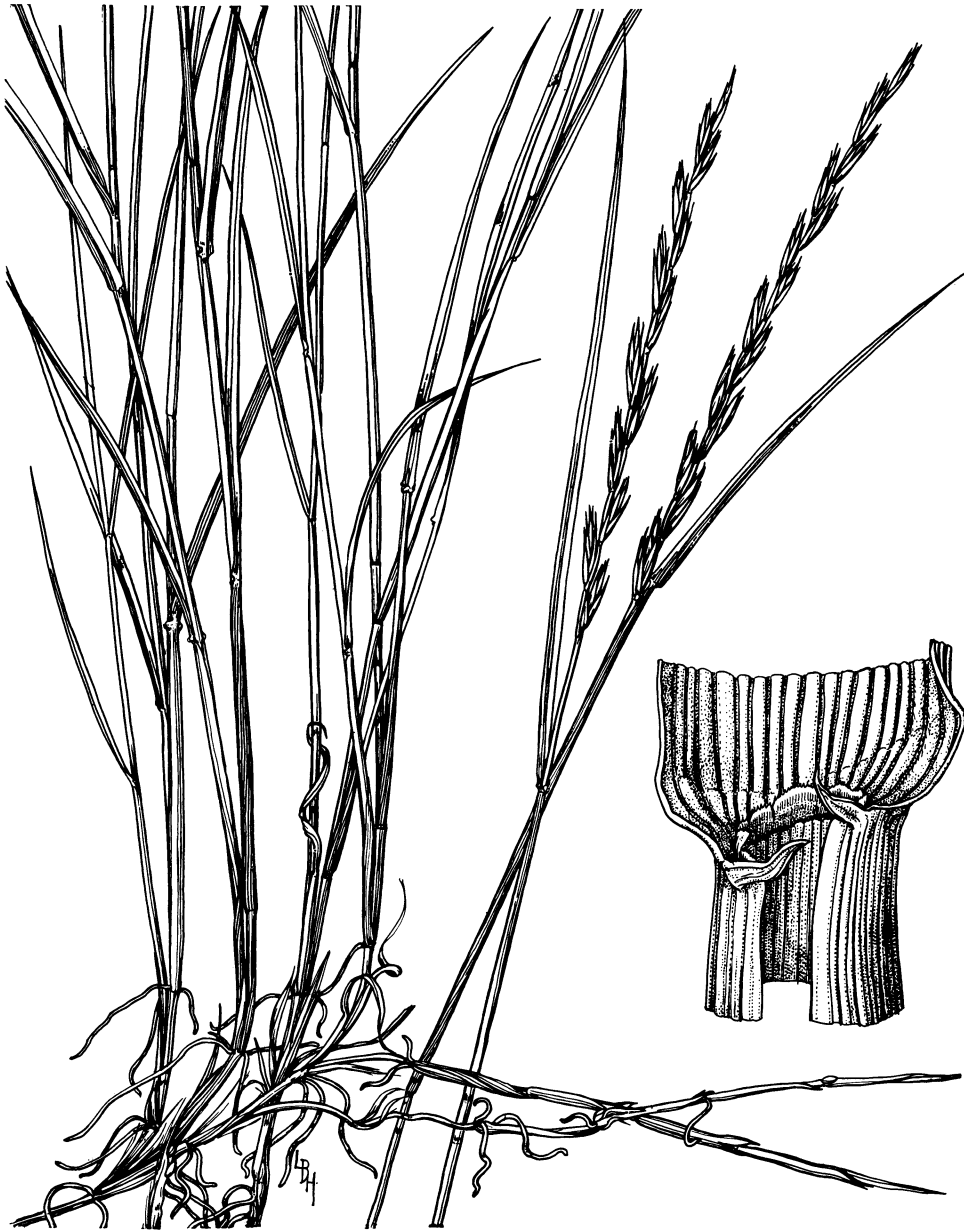


Plate VD.
Western wheatgrass,
P-727.
Plant $\times 2/5$;
spike $\times 2/3$;
ligule $\times 8 1/2$.

cross under field conditions. Plate VC shows the difference between streambank and thickspike wheatgrass.

WESTERN WHEATGRASS, *Agropyron smithii* Rydb., is a native grass common in the northern Great Plains but also found in the northern intermountain parts of the West (Plate VD). It occurs most frequently on moderately fine and fine textured soils that are inclusions in the Sierozem, Brown, and Chestnut soils where water from spring runoff has ponded and on Solonchak and Solonetz soils. This grass can grow through thick layers of silt along streams that flood out of their banks in the spring. Established stands of western wheatgrass endure long

periods of drought in temperate climates.

Western wheatgrass spreads by rhizomes to form an open but uniform sod that protects the soil from erosion. The young growth of pure stands of western wheatgrass is palatable to cattle and sheep, but the grass becomes coarse and harsh in early summer. When livestock have a choice between western wheatgrass and native or seeded bunch grasses, they graze bunch grasses first. Continuous early spring grazing of mixed stands soon results in pure stands of western wheatgrass. Fall regrowth of western wheatgrass cures well on the stem and is considered good winter range.

There are ecotypes of western wheatgrass that differ



Plate VIA.
Big bluegrass,
Sherman.
Plant $\times 2/5$;
spike $\times 4/5$;
spikelet, floret,
ligule $\times 5\frac{1}{4}$.

in forage and seed production, color, coarseness, and aggressiveness. All are relatively free from plant diseases, but ergot may occur. None of the ecotypes among 70 accessions has been sufficiently promising in either forage or seed production to warrant domestication. Other grasses in this group are better adapted, produce more, and are more useful in areas with predominantly winter wet-summer dry climate and on saline and alkali soils.

Group VI. The Bluegrasses

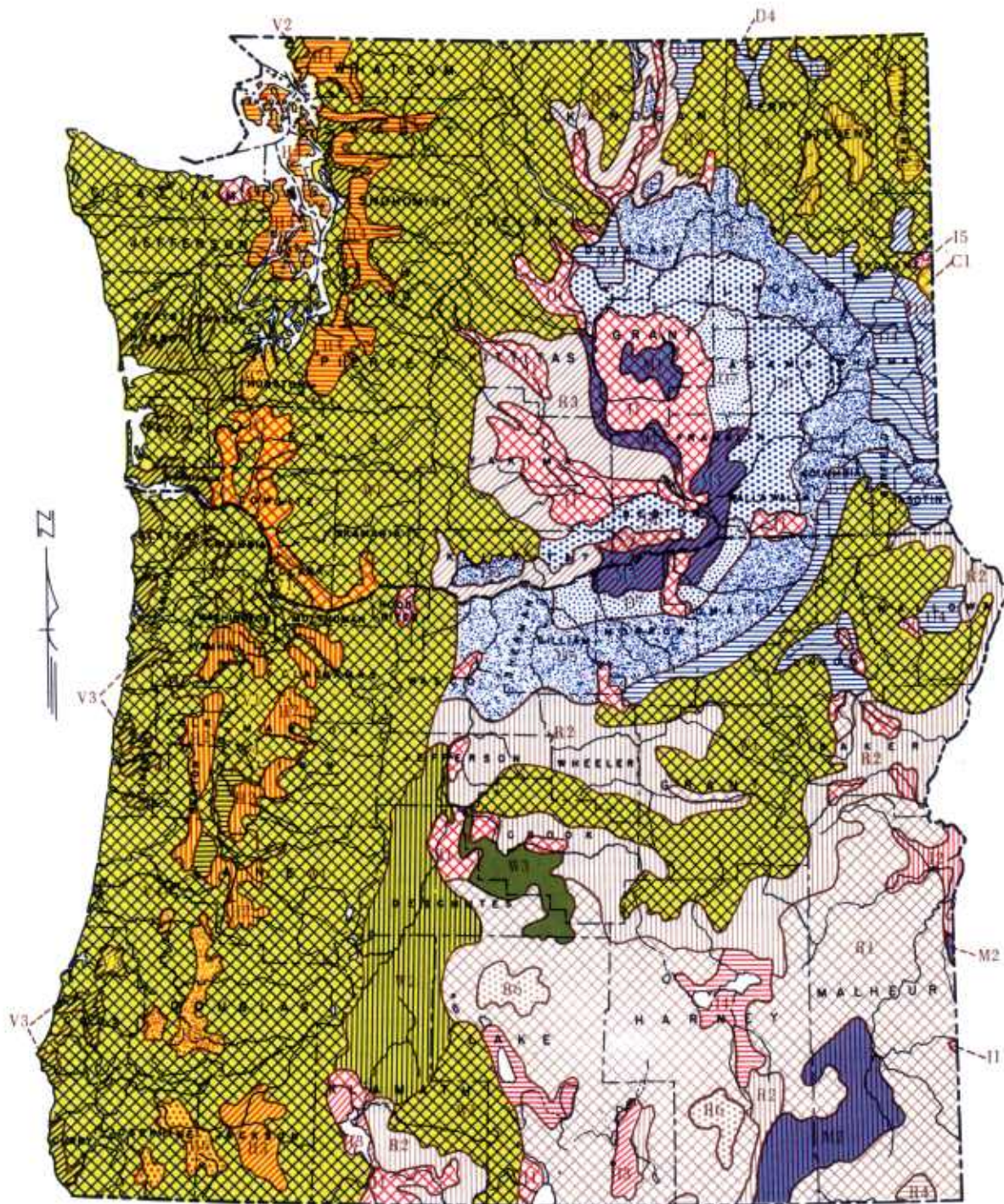
There are many species of bluegrasses. They are circumpolar, i.e., they occur on all continents; they are

closely related, highly variable, and apomictic but often hybridize to form new varieties or species. The ones used for conservation are both introduced and native. Three introduced bluegrasses — Kentucky, Canada, and bulbous — have become widely naturalized in the United States. Big bluegrass, a native species, has been domesticated. Other native species are in the process of domestication for conservation use.

The bluegrasses are divided into two groups. (1) The vernal-dominant bluegrasses, which start growth very early in the spring, are big bluegrass, bulbous bluegrass, and Canby bluegrass. They are all drought escaping. They make most of their growth early in the season

MAP LEGEND

- D. Nonirrigated cropland of the intermountain area; predominantly fall, winter, spring precipitation; cool; MAP and MAT vary widely with elevation.
1. Association of Chestnut and Chernozem soils with inclusions of Brown and Prairie; semiarid; short growing season; elevation above 4,000 feet; MAP 14-20 inches; grain-fallow.
 2. Association of Prairie, Gray-Brown Podzolic soils, and Grumusols; subhumid; MAP 20-30 inches; annual crops.
 3. Association of Chernozem, Prairie, and Gray-Brown Podzolic soils; subhumid; MAP 20-25 inches; annual crops.
 4. Association of Chernozem, Chestnut, and Prairie soils; subhumid; MAP 14-25 inches; grain-fallow.
 5. Association of Chestnut and Chernozem soils; semiarid to subhumid; MAP 12-16 inches; grain-fallow.
 6. Association of Brown and Chestnut soils; semiarid; MAP 10-12 inches; grain-fallow.
 7. Association of Brown soils, Regosols, and Lithosols; semiarid; MAP 8-10 inches; grain-fallow.
- C. Cutover timberlands of the intermountain area; climate cool; soil reaction acid; nonirrigated crops.
1. Association of Gray-Brown Podzolic, Brown Forest soils, and Planosols with inclusions of Prairie and Alluvial; subhumid; MAP 20-35 inches; mixed and part-time farming.
 2. Association of Brown Forest, Gray Wooded soils, and Lithosols with inclusions of Gray-Brown Podzolic and Alluvial; semiarid to subhumid; MAP 16-30 inches; hay, pasture, dairy.
 3. Association of Brown Podzolic soils, Lithosols, and Regosols with inclusion of Rock land; elevations 1,500-2,500 feet; humid; MAP 30-40 inches; hay and pasture.
 4. Association of Humic Gley and Alluvial soils with inclusions of Bog and Half Bog; humid; MAP 20-30 inches; hay and pasture.
- I. Irrigated land; climate predominantly arid to semiarid; growing season varies with elevation and latitude; soils vary in origin, depth, texture, drainage, and reaction.
1. Dominantly Sierozem and Brown soils; mostly season-long water; moderately well to well drained; soil reaction neutral to moderately alkaline.
 2. Association of Sierozem, Calcisols, Lithosols, and Solonetz soils with inclusions of Alluvial, Regosol, and Solonchak; imperfectly to well drained; warm dry summers.
 3. Dominantly Humic Gley and Alluvial soils with inclusions of Solonetz and Solonchak; some irrigable, seasonably wet from spring runoff; poorly to imperfectly drained.
 4. Association of Solonetz, Solonchak, and Alluvial soils; poorly to imperfectly drained; soil reaction strongly alkaline.
 5. Association of Prairie, Gray-Brown Podzolic soils, and Regosols; somewhat excessively drained; soil reaction medium acid to neutral; MAP 12-20 inches.
- R. Rangeland; climate cool, arid to subhumid, depending on elevation; inclusions of wet, seasonably wet, and irrigated areas varying in soil reaction; arable slopes can be reseeded.
1. Association of Sierozems, Brown soils, and Calcisols with inclusions of Lithosol, Regosol, Alluvial, and Solonetz; elevations 3,000-7,000 feet; MAP 6-14 inches.
 2. Association of Chestnut, Brown soils, and Lithosols with inclusions of Chernozem, Alluvial, Rock land, Regosol, and Solonetz; elevations 1,000-9,000 feet; MAP 11-19 inches.
 3. Association of Brown, Chestnut soils, and Lithosols with inclusions of Rock land, Regosol, Alluvial, and Solonetz; elevations 1,000-7,000 feet; MAP 8-16 inches.
 4. Dominantly Chestnut soils with inclusions of Brown, Chernozem, Lithosol, Alluvial, and Rock land; elevations 2,500-7,500 feet; MAP 12-20 inches.
 5. Association of Chernozem and Prairie soils with inclusions of Chestnut, Lithosol, Alluvial, and Rock land; elevations 5,000-9,000 feet; short growing season; MAP 14-30 inches.
 6. Association of Solonetz and Brown soils with inclusions of Regosol, Alluvial, Lithosol, and Humic Gley; elevations 4,000-5,200 feet; MAP 7-10 inches.
 7. Association of Solonetz and Solonchak soils with inclusions of Alluvial, Humic Gley, and Regosol; elevations 200-4,200 feet; MAP 2.5 to 12 inches.
- H. Coastal Upland; cutover foothills with inclusions of oak-grass savannas; elevations 100-1,200 feet; climate temperate to cool; subhumid to humid; soil reaction acid.
1. Association of Reddish-Brown Lateritic, Sols Bruns Acides, Alluvial, and Humic Gley soils; humid.
 2. Reddish-Brown Lateritic soils with inclusions of Gray-Brown Podzolic and Humic Gley; humid.
 3. Association of Reddish-Brown Lateritic soil, Grumusols, Alluvial, and Prairie soils; humid.
 4. Brown Podzolic soils with inclusions of Alluvial, Humic Gley, and Ground-Water Podzols; medium acid; from glacial material; humid.
 5. Association of Gray-Brown Podzolic and Reddish-Brown Lateritic soils with inclusions of Alluvial and Prairie; subhumid to humid.
 6. Association of Reddish-Brown Lateritic and Gray-Brown Podzolic soils with inclusions of Alluvial and Prairie; subhumid.
 7. Ando soils; excessively drained; low fertility; medium acid.
- V. Coastal Valleys; dominantly cropland; climate temperate to cool, subhumid to humid; soils range from poorly to excessively drained; alluvial and terrace; medium to strongly acid; elevations sea level to 200 feet.
1. Association of Alluvial, Gray-Brown Podzolic, Humic Gley soils, and Planosols; subhumid.
 2. Association of Alluvial and Humic Gley soils with inclusions of Low-Humic Gley, Bog, and Ground-Water Podzolic.
 3. Sols Bruns Acides with inclusions of Humic Gley, Ando, and Alluvial; soils medium to strongly acid; humid.
 4. Association of Planosols and Humic Gley soils with inclusions of Alluvial and Gray-Brown Podzolic; poorly drained; subhumid.
- M. Miscellaneous land; climate warm to cool, arid to subhumid, depending on elevation; mostly nonarable; inclusions of seedable range or pasture; mostly alkaline in reaction.
1. Badlands, dunes, lava flows, playas, Rock land, either alone or in association.
 2. Sierozem, Desert, and Alluvial soils with inclusions of Rock land, Solonetz, Regosol, and Humic Gley; elevations 2,200-6,000 feet; MAP 5-13 inches.
 3. Association of Regosols and Brown soils with inclusions of Alluvial, Chestnut, and Rock land; arid.
 4. Red Desert soils with inclusions of Alluvial, Calcisol, Badlands, Lithosol, Regosol, Rock land, Solonetz, and Solonchak; elevations 125-5,200 feet; MAP 3-12 inches.
 5. Peat.
- W. Mountainous areas; largely forested; climate cool to cold; subhumid to humid. Elevations sea level to over 14,000 feet; multiple use for forestry, grazing, watersheds, and wildlife.
1. Brown Podzolic, Gray Wooded, Brown Forest, Gray-Brown Podzolic soils, Podzols, and Sols Bruns Acides with inclusions of Planosol, Humic Gley, Low-Humic Gley, Lithosol, and Regosol; MAP 16-100 inches; elevations 50-12,000 feet.
 2. Regosols (pumice) with inclusions of Rock land, Lithosol, Alluvial, Humic Gley, Brown Podzolic, and Brown Forest; MAP 15-30 inches; elevation 4,500-7,000 feet.
 3. Brown soils with inclusions of Lithosol and Rock land, shallow, residual over basalt; MAP 10-13 inches; elevation 3,000-4,000 feet; dominated by juniper.



WEST COAST



WOODLAND



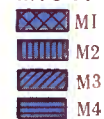
CUT OVER



RANGE



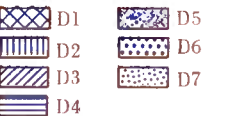
MISC.



IRRIGATED



NON-IRRIGATED INTERIOR

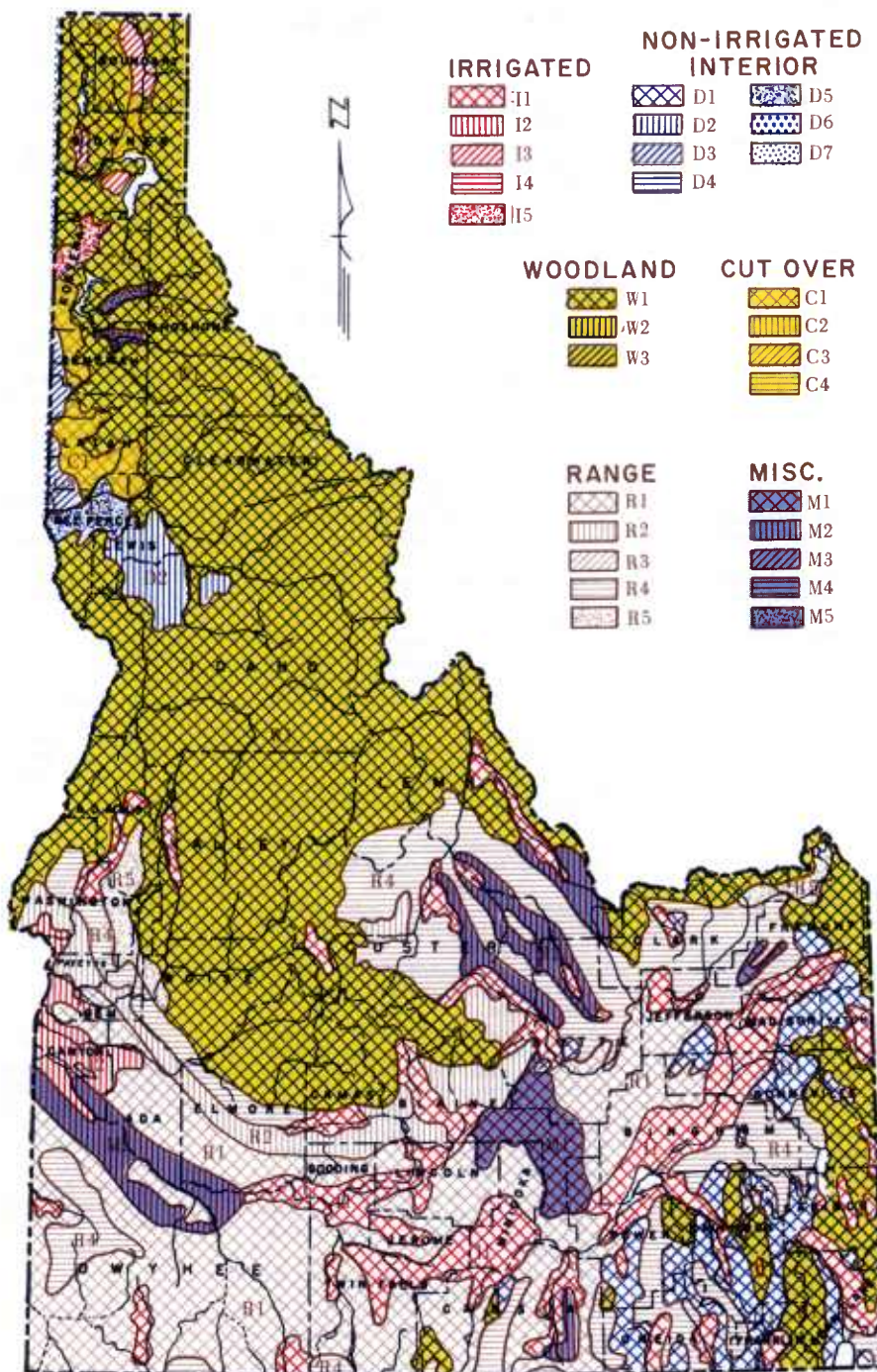


AGRICULTURAL ZONES WASHINGTON and OREGON



MAP LEGEND

- D. Nonirrigated cropland of the intermountain area; predominantly fall, winter, spring precipitation; cool; MAP and MAT vary widely with elevation.
1. Association of Chestnut and Chernozem soils with inclusions of Brown and Prairie; semiarid; short growing season; elevation above 4,000 feet; MAP 14-20 inches; grain-fallow.
 2. Association of Prairie, Gray-Brown Podzolic soils, and Grumusols; subhumid; MAP 20-30 inches; annual crops.
 3. Association of Chernozem, Prairie, and Gray-Brown Podzolic soils; subhumid; MAP 20-25 inches; annual crops.
 4. Association of Chernozem, Chestnut, and Prairie soils; subhumid; MAP 14-25 inches; grain-fallow.
 5. Association of Chestnut and Chernozem soils; semiarid to subhumid; MAP 12-16 inches; grain-fallow.
 6. Association of Brown and Chestnut soils; semiarid; MAP 10-12 inches; grain-fallow.
 7. Association of Brown soils, Regosols, and Lithosols; semiarid; MAP 8-10 inches; grain-fallow.
- C. Cutover timberlands of the intermountain area; climate cool; soil reaction acid; nonirrigated crops.
1. Association of Gray-Brown Podzolic, Brown Forest soils, and Planosols with inclusions of Prairie and Alluvial; subhumid; MAP 20-35 inches; mixed and part-time farming.
 2. Association of Brown Forest, Gray Wooded soils, and Lithosols with inclusions of Gray-Brown Podzolic and Alluvial; semiarid to subhumid; MAP 16-30 inches; hay, pasture, dairy.
 3. Association of Brown Podzolic soils, Lithosols, and Regosols with inclusion of Rock land; elevations 1,500-2,500 feet; humid; MAP 30-40 inches; hay and pasture.
 4. Association of Humic Gley and Alluvial soils with inclusions of Bog and Half Bog; humid; MAP 20-30 inches; hay and pasture.
- I. Irrigated land; climate predominantly arid to semiarid; growing season varies with elevation and latitude; soils vary in origin, depth, texture, drainage, and reaction.
1. Dominantly Sierozem and Brown soils; mostly season-long water; moderately well to well drained; soil reaction neutral to moderately alkaline.
 2. Association of Sierozem, Calcisols, Lithosols, and Solonetz soils with inclusions of Alluvial, Regosol, and Solonchak; imperfectly to well drained; warm dry summers.
 3. Dominantly Humic Gley and Alluvial soils with inclusions of Solonetz and Solonchak; some irrigable, seasonably wet from spring runoff; poorly to imperfectly drained.
 4. Association of Solonetz, Solonchak, and Alluvial soils; poorly to imperfectly drained; soil reaction strongly alkaline.
 5. Association of Prairie, Gray-Brown Podzolic soils, and Regosols; somewhat excessively drained; soil reaction medium acid to neutral; MAP 12-20 inches.
- R. Rangeland; climate cool, arid to subhumid, depending on elevation; inclusions of wet, seasonably wet, and irrigated areas varying in soil reaction; arable slopes can be reseeded.
1. Association of Sierozems, Brown soils, and Calcisols with inclusions of Lithosol, Regosol, Alluvial, and Solonetz; elevations 3,000-7,000 feet; MAP 6-14 inches.
 2. Association of Chestnut, Brown soils, and Lithosols with inclusions of Chernozem, Alluvial, Rock land, Regosol, and Solonetz; elevations 1,000-9,000 feet; MAP 11-19 inches.
 3. Association of Brown, Chestnut soils, and Lithosols with inclusions of Rock land, Regosol, Alluvial, and Solonetz; elevations 1,000-7,000 feet; MAP 8-16 inches.
 4. Dominantly Chestnut soils with inclusions of Brown, Chernozem, Lithosol, Alluvial, and Rock land; elevations 2,500-7,500 feet; MAP 12-20 inches.
 5. Association of Chernozem and Prairie soils with inclusions of Chestnut, Lithosol, Alluvial, and Rock land; elevations 5,000-9,000 feet; short growing season; MAP 14-30 inches.
 6. Association of Solonetz and Brown soils with inclusions of Regosol, Alluvial, Lithosol, and Humic Gley; elevations 4,000-5,200 feet; MAP 7-10 inches.
 7. Association of Solonetz and Solonchak soils with inclusions of Alluvial, Humic Gley, and Regosol; elevations 200-4,200 feet; MAP 2.5 to 12 inches.
- H. Coastal Upland; cutover foothills with inclusions of oak-gress savannas; elevations 100-1,200 feet; climate temperate to cool; subhumid to humid; soil reaction acid.
1. Association of Reddish-Brown Lateritic, Sols Bruns Acides, Alluvial, and Humic Gley soils; humid.
 2. Reddish-Brown Lateritic soils with inclusions of Gray-Brown Podzolic and Humic Gley; humid.
 3. Association of Reddish-Brown Lateritic soil, Grumusols, Alluvial, and Prairie soils; humid.
 4. Brown Podzolic soils with inclusions of Alluvial, Humic Gley, and Ground-Water Podzols; medium acid; from glacial material; humid.
 5. Association of Gray-Brown Podzolic and Reddish-Brown Lateritic soils with inclusions of Alluvial and Prairie; subhumid to humid.
 6. Association of Reddish-Brown Lateritic and Gray-Brown Podzolic soils with inclusions of Alluvial and Prairie; subhumid.
 7. Ando soils; excessively drained; low fertility; medium acid.
- V. Coastal Valleys; dominantly cropland; climate temperate to cool, subhumid to humid; soils range from poorly to excessively drained; alluvial and terrace; medium to strongly acid; elevations sea level to 200 feet.
1. Association of Alluvial, Gray-Brown Podzolic, Humic Gley soils, and Planosols; subhumid.
 2. Association of Alluvial and Humic Gley soils with inclusions of Low-Humic Gley, Bog, and Ground-Water Podzolic.
 3. Sols Bruns Acides with inclusions of Humic Gley, Ando, and Alluvial; soils medium to strongly acid; humid.
 4. Association of Planosols and Humic Gley soils with inclusions of Alluvial and Gray-Brown Podzolic; poorly drained; subhumid.
- M. Miscellaneous land; climate warm to cool, arid to subhumid, depending on elevation; mostly nonarable; inclusions of seedable range or pasture; mostly alkaline in reaction.
1. Badlands, dunes, lava flows, playas, Rock land, either alone or in association.
 2. Sierozem, Desert, and Alluvial soils with inclusions of Rock land, Solonetz, Regosol, and Humic Gley; elevations 2,200-6,000 feet; MAP 5-13 inches.
 3. Association of Regosols and Brown soils with inclusions of Alluvial, Chestnut, and Rock land; arid.
 4. Red Desert soils with inclusions of Alluvial, Calcisol, Badlands, Lithosol, Regosol, Rock land, Solonetz, and Solonchak; elevations 125-5,200 feet; MAP 3-12 inches.
 5. Peat.
- W. Mountainous areas; largely forested; climate cool to cold; subhumid to humid. Elevations sea level to over 14,000 feet; multiple use for forestry, grazing, watersheds, and wildlife.
1. Brown Podzolic, Gray Wooded, Brown Forest, Gray-Brown Podzolic soils, Podzols, and Sols Bruns Acides with inclusions of Planosol, Humic Gley, Low-Humic Gley, Lithosol, and Regosol; MAP 16-100 inches; elevations 50-12,000 feet.
 2. Regosols (pumice) with inclusions of Rock land, Lithosol, Alluvial, Humic Gley, Brown Podzolic, and Brown Forest; MAP 15-30 inches; elevation 4,500-7,000 feet.
 3. Brown soils with inclusions of Lithosol and Rock land, shallow, residual over basalt; MAP 10-13 inches; elevation 3,000-4,000 feet; dominated by juniper.



AGRICULTURAL ZONES IDAHO

25 0 25 50 75 100
SCALE IN MILES

MAP LEGEND

- D. Nonirrigated cropland of the intermountain area; predominantly fall, winter, spring precipitation; cool; MAP and MAT vary widely with elevation.
1. Association of Chestnut and Chernozem soils with inclusions of Brown and Prairie; semiarid; short growing season; elevation above 4,000 feet; MAP 14-20 inches; grain-fallow.
 2. Association of Prairie, Gray-Brown Podzolic soils, and Grumusols; subhumid; MAP 20-30 inches; annual crops.
 3. Association of Chernozem, Prairie, and Gray-Brown Podzolic soils; subhumid; MAP 20-25 inches; annual crops.
 4. Association of Chernozem, Chestnut, and Prairie soils; subhumid; MAP 14-25 inches; grain-fallow.
 5. Association of Chestnut and Chernozem soils; semiarid to subhumid; MAP 12-16 inches; grain-fallow.
 6. Association of Brown and Chestnut soils; semiarid; MAP 10-12 inches; grain-fallow.
 7. Association of Brown soils, Regosols, and Lithosols; semiarid; MAP 8-10 inches; grain-fallow.
- C. Cutover timberlands of the intermountain area; climate cool; soil reaction acid; nonirrigated crops.
1. Association of Gray-Brown Podzolic, Brown Forest soils, and Planosols with inclusions of Prairie and Alluvial; subhumid; MAP 20-35 inches; mixed and part-time farming.
 2. Association of Brown Forest, Gray Wooded soils, and Lithosols with inclusions of Gray-Brown Podzolic and Alluvial; semiarid to subhumid; MAP 16-30 inches; hay, pasture, dairy.
 3. Association of Brown Podzolic soils, Lithosols, and Regosols with inclusion of Rock land; elevations 1,500-2,500 feet; humid; MAP 30-40 inches; hay and pasture.
 4. Association of Humic Gley and Alluvial soils with inclusions of Bog and Half Bog; humid; MAP 20-30 inches; hay and pasture.
- I. Irrigated land; climate predominantly arid to semiarid; growing season varies with elevation and latitude; soils vary in origin, depth, texture, drainage, and reaction.
1. Dominantly Sierozem and Brown soils; mostly season-long water; moderately well to well drained; soil reaction neutral to moderately alkaline.
 2. Association of Sierozem, Calcisols, Lithosols, and Solonetz soils with inclusions of Alluvial, Regosol, and Solonchak; imperfectly to well drained; warm dry summers.
 3. Dominantly Humic Gley and Alluvial soils with inclusions of Solonetz and Solonchak; some irrigable, seasonably wet from spring runoff; poorly to imperfectly drained.
 4. Association of Solonetz, Solonchak, and Alluvial soils; poorly to imperfectly drained; soil reaction strongly alkaline.
 5. Association of Prairie, Gray-Brown Podzolic soils, and Regosols; somewhat excessively drained; soil reaction medium acid to neutral; MAP 12-20 inches.
- R. Rangeland; climate cool, arid to subhumid, depending on elevation; inclusions of wet, seasonably wet, and irrigated areas varying in soil reaction; arable slopes can be reseeded.
1. Association of Sierozems, Brown soils, and Calcisols with inclusions of Lithosol, Regosol, Alluvial, and Solonetz; elevations 3,000-7,000 feet; MAP 6-14 inches.
 2. Association of Chestnut, Brown soils, and Lithosols with inclusions of Chernozem, Alluvial, Rock land, Regosol, and Solonetz; elevations 1,000-9,000 feet; MAP 11-19 inches.
 3. Association of Brown, Chestnut soils, and Lithosols with inclusions of Rock land, Regosol, Alluvial, and Solonetz; elevations 1,000-7,000 feet; MAP 8-16 inches.
 4. Dominantly Chestnut soils with inclusions of Brown, Chernozem, Lithosol, Alluvial, and Rock land; elevations 2,500-7,500 feet; MAP 12-20 inches.
 5. Association of Chernozem and Prairie soils with inclusions of Chestnut, Lithosol, Alluvial, and Rock land; elevations 5,000-9,000 feet; short growing season; MAP 14-30 inches.
 6. Association of Solonetz and Brown soils with inclusions of Regosol, Alluvial, Lithosol, and Humic Gley; elevations 4,000-5,200 feet; MAP 7-10 inches.
 7. Association of Solonetz and Solonchak soils with inclusions of Alluvial, Humic Gley, and Regosol; elevations 200-4,200 feet; MAP 2.5 to 12 inches.
- H. Coastal Upland; cutover foothills with inclusions of oak-gress savannas; elevations 100-1,200 feet; climate temperate to cool; subhumid to humid; soil reaction acid.
1. Association of Reddish-Brown Lateritic, Sols Bruns Acides, Alluvial, and Humic Gley soils; humid.
 2. Reddish-Brown Lateritic soils with inclusions of Gray-Brown Podzolic and Humic Gley; humid.
 3. Association of Reddish-Brown Lateritic soil, Grumusols, Alluvial, and Prairie soils; humid.
 4. Brown Podzolic soils with inclusions of Alluvial, Humic Gley, and Ground-Water Podzols; medium acid; from glacial material; humid.
 5. Association of Gray-Brown Podzolic and Reddish-Brown Lateritic soils with inclusions of Alluvial and Prairie; subhumid to humid.
 6. Association of Reddish-Brown Lateritic and Gray-Brown Podzolic soils with inclusions of Alluvial and Prairie; subhumid.
 7. Ando soils; excessively drained; low fertility; medium acid.
- V. Coastal Valleys; dominantly cropland; climate temperate to cool, subhumid to humid; soils range from poorly to excessively drained; alluvial and terrace; medium to strongly acid; elevations sea level to 200 feet.
1. Association of Alluvial, Gray-Brown Podzolic, Humic Gley soils, and Planosols; subhumid.
 2. Association of Alluvial and Humic Gley soils with inclusions of Low-Humic Gley, Bog, and Ground-Water Podzolic.
 3. Sols Bruns Acides with inclusions of Humic Gley, Ando, and Alluvial; soils medium to strongly acid; humid.
 4. Association of Planosols and Humic Gley soils with inclusions of Alluvial and Gray-Brown Podzolic; poorly drained; subhumid.
- M. Miscellaneous land; climate warm to cool, arid to subhumid, depending on elevation; mostly nonarable; inclusions of seedable range or pasture; mostly alkaline in reaction.
1. Badlands, dunes, lava flows, playas, Rock land, either alone or in association.
 2. Sierozem, Desert, and Alluvial soils with inclusions of Rock land, Solonetz, Regosol, and Humic Gley; elevations 2,200-6,000 feet; MAP 5-13 inches.
 3. Association of Regosols and Brown soils with inclusions of Alluvial, Chestnut, and Rock land; arid.
 4. Red Desert soils with inclusions of Alluvial, Calcisol, Badlands, Lithosol, Regosol, Rock land, Solonetz, and Solonchak; elevations 125-5,200 feet; MAP 3-12 inches.
5. Peat.
- W. Mountainous areas; largely forested; climate cool to cold; subhumid to humid. Elevations sea level to over 14,000 feet; multiple use for forestry, grazing, watersheds, and wildlife.
1. Brown Podzolic, Gray Wooded, Brown Forest, Gray-Brown Podzolic soils, Podzols, and Sols Bruns Acides with inclusions of Planosol, Humic Gley, Low-Humic Gley, Lithosol, and Regosol; MAP 16-100 inches; elevations 50-12,000 feet.
 2. Regosols (pumice) with inclusions of Rock land, Lithosol, Alluvial, Humic Gley, Brown Podzolic, and Brown Forest; MAP 15-30 inches; elevation 4,500-7,000 feet.
 3. Brown soils with inclusions of Lithosol and Rock land, shallow, residual over basalt; MAP 10-13 inches; elevation 3,000-4,000 feet; dominated by juniper.

WOODLAND



IRRIGATED



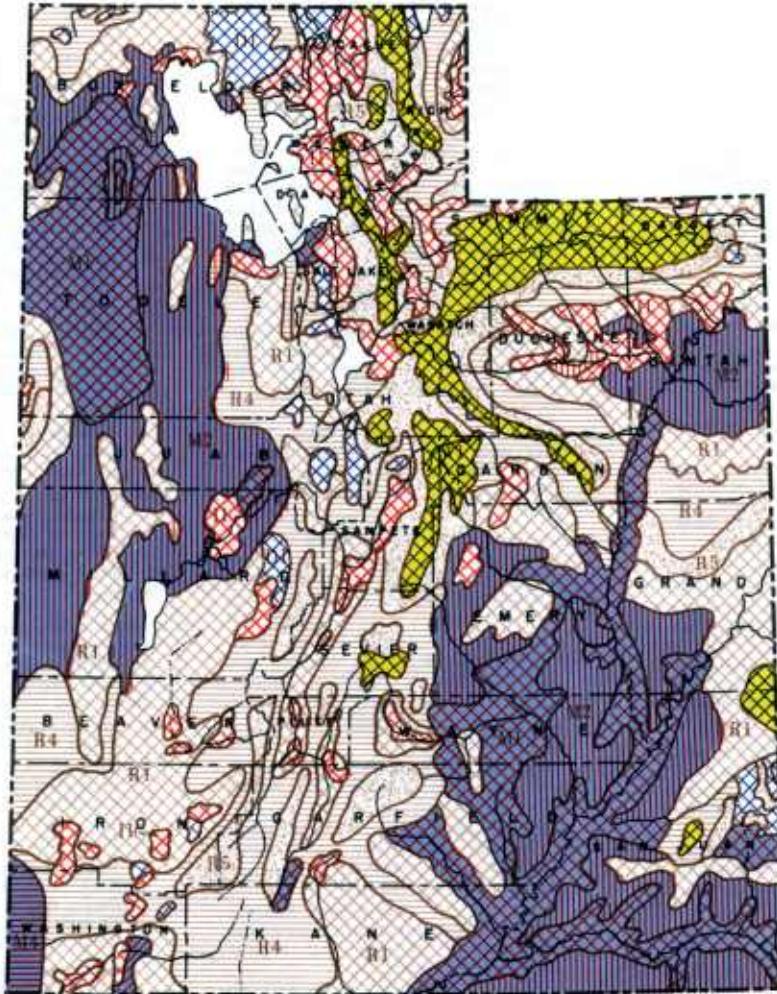
NON-IRRIGATED INTERIOR



RANGE

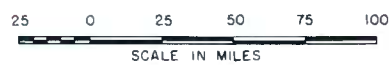


MISC.



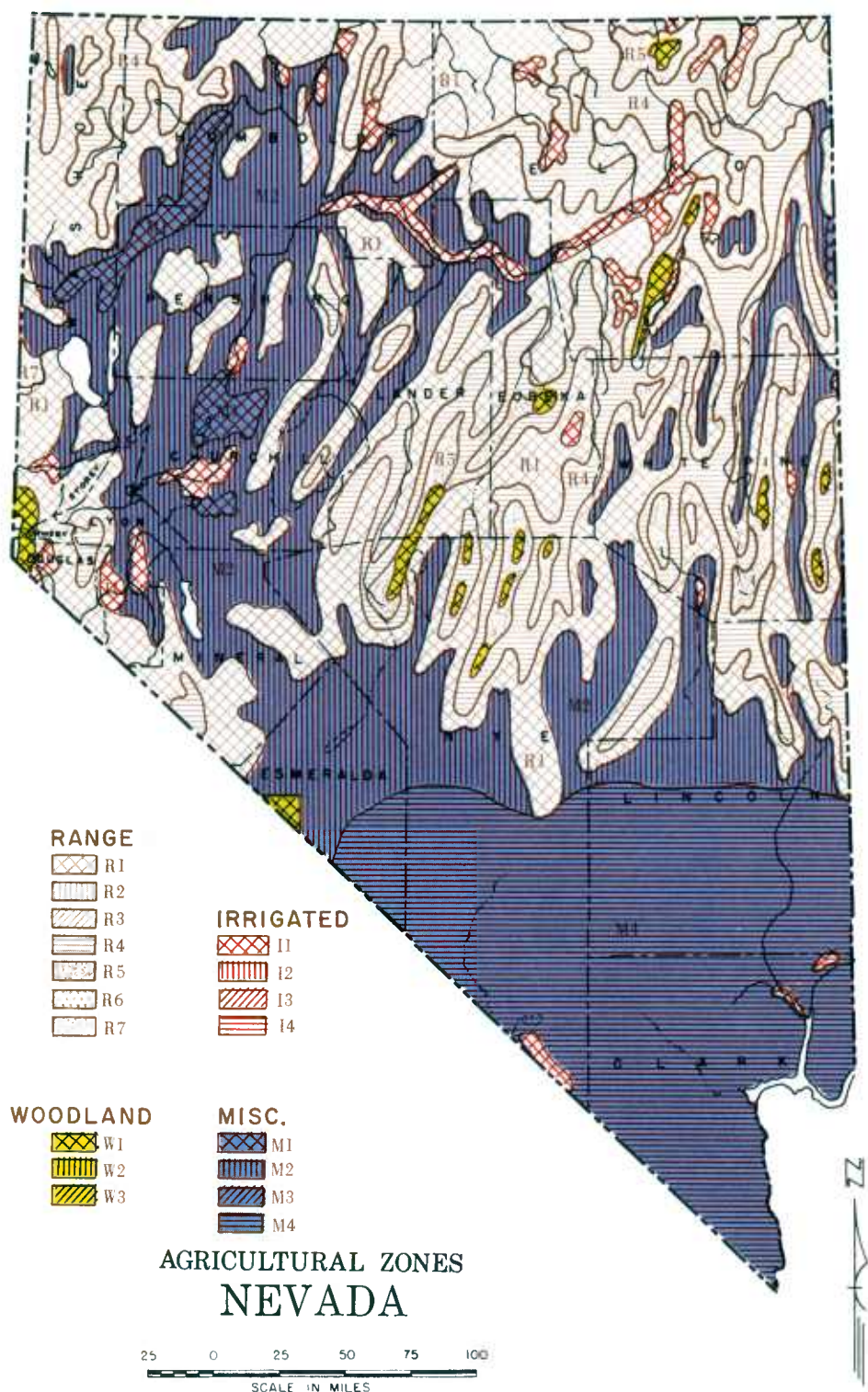
AGRICULTURAL ZONES

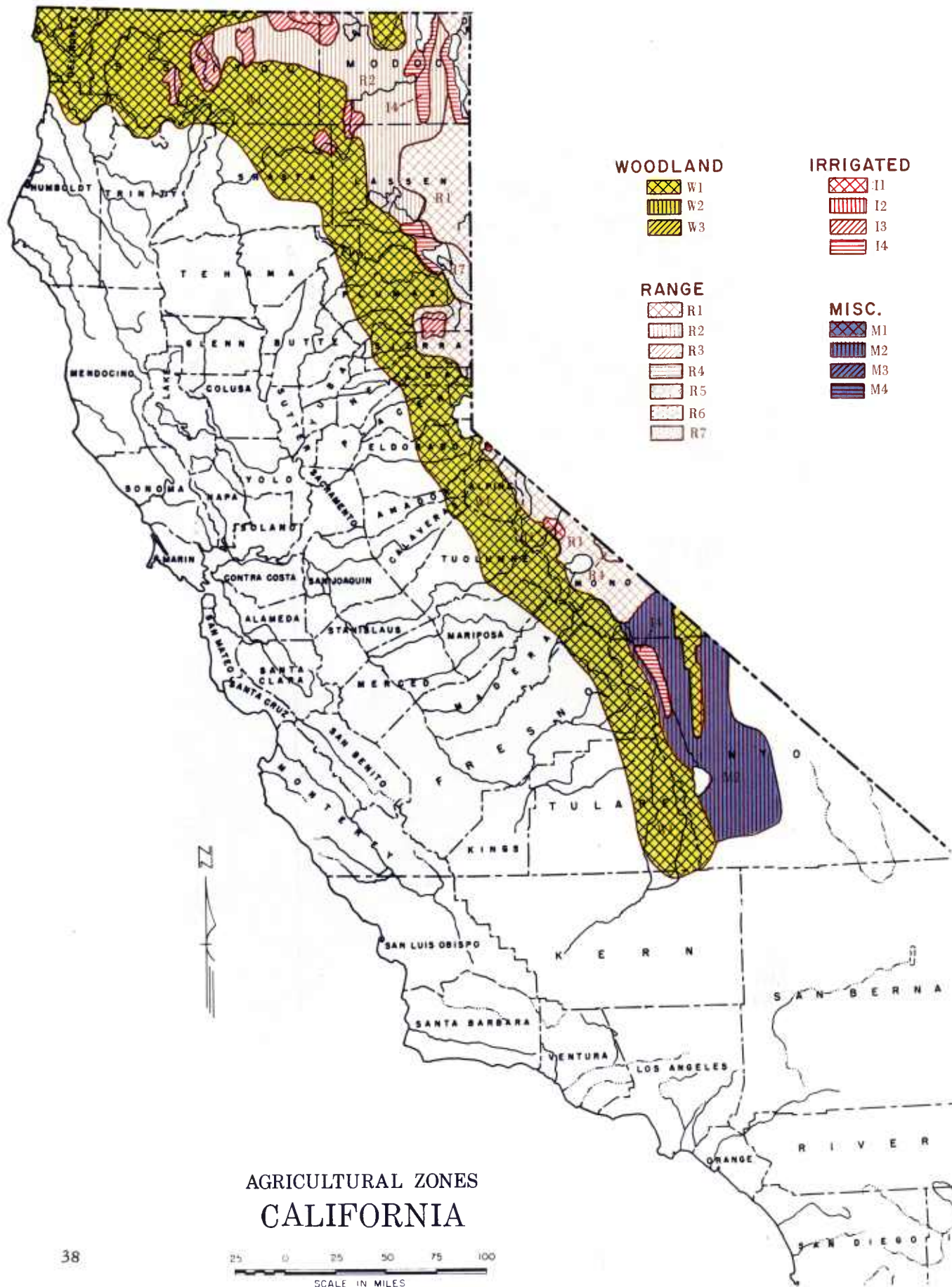
UTAH



MAP LEGEND

- D. Nonirrigated cropland of the intermountain area; predominantly fall, winter, spring precipitation; cool; MAP and MAT vary widely with elevation.
1. Association of Chestnut and Chernozem soils with inclusions of Brown and Prairie; semiarid; short growing season; elevation above 4,000 feet; MAP 14-20 inches; grain-fallow.
 2. Association of Prairie, Gray-Brown Podzolic soils, and Grumusols; subhumid; MAP 20-30 inches; annual crops.
 3. Association of Chernozem, Prairie, and Gray-Brown Podzolic soils; subhumid; MAP 20-25 inches; annual crops.
 4. Association of Chernozem, Chestnut, and Prairie soils; subhumid; MAP 14-25 inches; grain-fallow.
 5. Association of Chestnut and Chernozem soils; semiarid to subhumid; MAP 12-16 inches; grain-fallow.
 6. Association of Brown and Chestnut soils; semiarid; MAP 10-12 inches; grain-fallow.
 7. Association of Brown soils, Regosols, and Lithosols; semiarid; MAP 8-10 inches; grain-fallow.
- C. Cutover timberlands of the intermountain area; climate cool; soil reaction acid; nonirrigated crops.
1. Association of Gray-Brown Podzolic, Brown Forest soils, and Planosols with inclusions of Prairie and Alluvial; subhumid; MAP 20-35 inches; mixed and part-time farming.
 2. Association of Brown Forest, Gray Wooded soils, and Lithosols with inclusions of Gray-Brown Podzolic and Alluvial; semiarid to subhumid; MAP 16-30 inches; hay, pasture, dairy.
 3. Association of Brown Podzolic soils, Lithosols, and Regosols with inclusion of Rock land; elevations 1,500-2,500 feet; humid; MAP 30-40 inches; hay and pasture.
 4. Association of Humic Gley and Alluvial soils with inclusions of Bog and Half Bog; humid; MAP 20-30 inches; hay and pasture.
- I. Irrigated land; climate predominantly arid to semiarid; growing season varies with elevation and latitude; soils vary in origin, depth, texture, drainage, and reaction.
1. Dominantly Sierozem and Brown soils; mostly season-long water; moderately well to well drained; soil reaction neutral to moderately alkaline.
 2. Association of Sierozem, Calcisols, Lithosols, and Solonetz soils with inclusions of Alluvial, Regosol, and Solonchak; imperfectly to well drained; warm dry summers.
 3. Dominantly Humic Gley and Alluvial soils with inclusions of Solonetz and Solonchak; some irrigable, seasonably wet from spring runoff; poorly to imperfectly drained.
 4. Association of Solonetz, Solonchak, and Alluvial soils; poorly to imperfectly drained; soil reaction strongly alkaline.
 5. Association of Prairie, Gray-Brown Podzolic soils, and Regosols; somewhat excessively drained; soil reaction medium acid to neutral; MAP 12-20 inches.
- R. Rangeland; climate cool, arid to subhumid, depending on elevation; inclusions of wet, seasonably wet, and irrigated areas varying in soil reaction; arable slopes can be reseeded.
1. Association of Sierozems, Brown soils, and Calcisols with inclusions of Lithosol, Regosol, Alluvial, and Solonetz; elevations 3,000-7,000 feet; MAP 6-14 inches.
 2. Association of Chestnut, Brown soils, and Lithosols with inclusions of Chernozem, Alluvial, Rock land, Regosol, and Solonetz; elevations 1,000-9,000 feet; MAP 11-19 inches.
 3. Association of Brown, Chestnut soils, and Lithosols with inclusions of Rock land, Regosol, Alluvial, and Solonetz; elevations 1,000-7,000 feet; MAP 8-16 inches.
 4. Dominantly Chestnut soils with inclusions of Brown, Chernozem, Lithosol, Alluvial, and Rock land; elevations 2,500-7,500 feet; MAP 12-20 inches.
 5. Association of Chernozem and Prairie soils with inclusions of Chestnut, Lithosol, Alluvial, and Rock land; elevations 5,000-9,000 feet; short growing season; MAP 14-30 inches.
 6. Association of Solonetz and Brown soils with inclusions of Regosol, Alluvial, Lithosol, and Humic Gley; elevations 4,000-5,200 feet; MAP 7-10 inches.
 7. Association of Solonetz and Solonchak soils with inclusions of Alluvial, Humic Gley, and Regosol; elevations 200-4,200 feet; MAP 2.5 to 12 inches.
- H. Coastal Upland; cutover foothills with inclusions of oak-gress savannas; elevations 100-1,200 feet; climate temperate to cool; subhumid to humid; soil reaction acid.
1. Association of Reddish-Brown Lateritic, Sols Bruns Acides, Alluvial, and Humic Gley soils; humid.
 2. Reddish-Brown Lateritic soils with inclusions of Gray-Brown Podzolic and Humic Gley; humid.
 3. Association of Reddish-Brown Lateritic soil, Grumusols, Alluvial, and Prairie soils; humid.
 4. Brown Podzolic soils with inclusions of Alluvial, Humic Gley, and Ground-Water Podzols; medium acid; from glacial material; humid.
 5. Association of Gray-Brown Podzolic and Reddish-Brown Lateritic soils with inclusions of Alluvial and Prairie; subhumid to humid.
 6. Association of Reddish-Brown Lateritic and Gray-Brown Podzolic soils with inclusions of Alluvial and Prairie; subhumid.
 7. Ando soils; excessively drained; low fertility; medium acid.
- V. Coastal Valleys; dominantly cropland; climate temperate to cool, subhumid to humid; soils range from poorly to excessively drained; alluvial and terrace; medium to strongly acid; elevations sea level to 200 feet.
1. Association of Alluvial, Gray-Brown Podzolic, Humic Gley soils, and Planosols; subhumid.
 2. Association of Alluvial and Humic Gley soils with inclusions of Low-Humic Gley, Bog, and Ground-Water Podzolic.
 3. Sols Bruns Acides with inclusions of Humic Gley, Ando, and Alluvial; soils medium to strongly acid; humid.
 4. Association of Planosols and Humic Gley soils with inclusions of Alluvial and Gray-Brown Podzolic; poorly drained; subhumid.
- M. Miscellaneous land; climate warm to cool, arid to subhumid, depending on elevation; mostly nonarable; inclusions of seedable range or pasture; mostly alkaline in reaction.
1. Badlands, dunes, lava flows, playas, Rock land, either alone or in association.
 2. Sierozem, Desert, and Alluvial soils with inclusions of Rock land, Solonetz, Regosol, and Humic Gley; elevations 2,200-6,000 feet; MAP 5-13 inches.
 3. Association of Regosols and Brown soils with inclusions of Alluvial, Chestnut, and Rock land; arid.
 4. Red Desert soils with inclusions of Alluvial, Calcisol, Badlands, Lithosol, Regosol, Rock land, Solonetz, and Solonchak; elevations 125-5,200 feet; MAP 3-12 inches.
 5. Peat.
- W. Mountainous areas; largely forested; climate cool to cold; subhumid to humid. Elevations sea level to over 14,000 feet; multiple use for forestry, grazing, watersheds, and wildlife.
1. Brown Podzolic, Gray Wooded, Brown Forest, Gray-Brown Podzolic soils, Podzols, and Sols Bruns Acides with inclusions of Planosol, Humic Gley, Low-Humic Gley, Lithosol, and Regosol; MAP 16-100 inches; elevations 50-12,000 feet.
 2. Regosols (pumice) with inclusions of Rock land, Lithosol, Alluvial, Humic Gley, Brown Podzolic, and Brown Forest; MAP 15-30 inches; elevation 4,500-7,000 feet.
 3. Brown soils with inclusions of Lithosol and Rock land, shallow, residual over basalt; MAP 10-13 inches; elevation 3,000-4,000 feet; dominated by juniper.





AGRICULTURAL ZONES CALIFORNIA

MAP LEGEND

- D. Nonirrigated cropland of the intermountain area; predominantly fall, winter, spring precipitation; cool; MAP and MAT vary widely with elevation.
1. Association of Chestnut and Chernozem soils with inclusions of Brown and Prairie; semiarid; short growing season; elevation above 4,000 feet; MAP 14-20 inches; grain-fallow.
 2. Association of Prairie, Gray-Brown Podzolic soils, and Grumusols; subhumid; MAP 20-30 inches; annual crops.
 3. Association of Chernozem, Prairie, and Gray-Brown Podzolic soils; subhumid; MAP 20-25 inches; annual crops.
 4. Association of Chernozem, Chestnut, and Prairie soils; subhumid; MAP 14-25 inches; grain-fallow.
 5. Association of Chestnut and Chernozem soils; semiarid to subhumid; MAP 12-16 inches; grain-fallow.
 6. Association of Brown and Chestnut soils; semiarid; MAP 10-12 inches; grain-fallow.
 7. Association of Brown soils, Regosols, and Lithosols; semiarid; MAP 8-10 inches; grain-fallow.
- C. Cutover timberlands of the intermountain area; climate cool; soil reaction acid; nonirrigated crops.
1. Association of Gray-Brown Podzolic, Brown Forest soils, and Planosols with inclusions of Prairie and Alluvial; subhumid; MAP 20-35 inches; mixed and part-time farming.
 2. Association of Brown Forest, Gray Wooded soils, and Lithosols with inclusions of Gray-Brown Podzolic and Alluvial; semiarid to subhumid; MAP 16-30 inches; hay, pasture, dairy.
 3. Association of Brown Podzolic soils, Lithosols, and Regosols with inclusion of Rock land; elevations 1,500-2,500 feet; humid; MAP 30-40 inches; hay and pasture.
 4. Association of Humic Gley and Alluvial soils with inclusions of Bog and Half Bog; humid; MAP 20-30 inches; hay and pasture.
- I. Irrigated land; climate predominantly arid to semiarid; growing season varies with elevation and latitude; soils vary in origin, depth, texture, drainage, and reaction.
1. Dominantly Sierozem and Brown soils; mostly season-long water; moderately well to well drained; soil reaction neutral to moderately alkaline.
 2. Association of Sierozem, Calcisols, Lithosols, and Solonetz soils with inclusions of Alluvial, Regosol, and Solonchak; imperfectly to well drained; warm dry summers.
 3. Dominantly Humic Gley and Alluvial soils with inclusions of Solonetz and Solonchak; some irrigable, seasonably wet from spring runoff; poorly to imperfectly drained.
 4. Association of Solonetz, Solonchak, and Alluvial soils; poorly to imperfectly drained; soil reaction strongly alkaline.
 5. Association of Prairie, Gray-Brown Podzolic soils, and Regosols; somewhat excessively drained; soil reaction medium acid to neutral; MAP 12-20 inches.
- R. Rangeland; climate cool, arid to subhumid, depending on elevation; inclusions of wet, seasonably wet, and irrigated areas varying in soil reaction; arable slopes can be reseeded.
1. Association of Sierozems, Brown soils, and Calcisols with inclusions of Lithosol, Regosol, Alluvial, and Solonetz; elevations 3,000-7,000 feet; MAP 6-14 inches.
 2. Association of Chestnut, Brown soils, and Lithosols with inclusions of Chernozem, Alluvial, Rock land, Regosol, and Solonetz; elevations 1,000-9,000 feet; MAP 11-19 inches.
 3. Association of Brown, Chestnut soils, and Lithosols with inclusions of Rock land, Regosol, Alluvial, and Solonetz; elevations 1,000-7,000 feet; MAP 8-16 inches.
 4. Dominantly Chestnut soils with inclusions of Brown, Chernozem, Lithosol, Alluvial, and Rock land; elevations 2,500-7,500 feet; MAP 12-20 inches.
 5. Association of Chernozem and Prairie soils with inclusions of Chestnut, Lithosol, Alluvial, and Rock land; elevations 5,000-9,000 feet; short growing season; MAP 14-30 inches.
 6. Association of Solonetz and Brown soils with inclusions of Regosol, Alluvial, Lithosol, and Humic Gley; elevations 4,000-5,200 feet; MAP 7-10 inches.
 7. Association of Solonetz and Solonchak soils with inclusions of Alluvial, Humic Gley, and Regosol; elevations 200-4,200 feet; MAP 2.5 to 12 inches.
- H. Coastal Upland; cutover foothills with inclusions of oak-gress savannas; elevations 100-1,200 feet; climate temperate to cool; subhumid to humid; soil reaction acid.
1. Association of Reddish-Brown Lateritic, Sols Bruns Acides, Alluvial, and Humic Gley soils; humid.
 2. Reddish-Brown Lateritic soils with inclusions of Gray-Brown Podzolic and Humic Gley; humid.
 3. Association of Reddish-Brown Lateritic soil, Grumusols, Alluvial, and Prairie soils; humid.
 4. Brown Podzolic soils with inclusions of Alluvial, Humic Gley, and Ground-Water Podzols; medium acid; from glacial material; humid.
 5. Association of Gray-Brown Podzolic and Reddish-Brown Lateritic soils with inclusions of Alluvial and Prairie; subhumid to humid.
 6. Association of Reddish-Brown Lateritic and Gray-Brown Podzolic soils with inclusions of Alluvial and Prairie; subhumid.
 7. Ando soils; excessively drained; low fertility; medium acid.
- V. Coastal Valleys; dominantly cropland; climate temperate to cool, subhumid to humid; soils range from poorly to excessively drained; alluvial and terrace; medium to strongly acid; elevations sea level to 200 feet.
1. Association of Alluvial, Gray-Brown Podzolic, Humic Gley soils, and Planosols; subhumid.
 2. Association of Alluvial and Humic Gley soils with inclusions of Low-Humic Gley, Bog, and Ground-Water Podzolic.
 3. Sols Bruns Acides with inclusions of Humic Gley, Ando, and Alluvial; soils medium to strongly acid; humid.
 4. Association of Planosols and Humic Gley soils with inclusions of Alluvial and Gray-Brown Podzolic; poorly drained; subhumid.
- M. Miscellaneous land; climate warm to cool, arid to subhumid, depending on elevation; mostly nonarable; inclusions of seedable range or pasture; mostly alkaline in reaction.
1. Badlands, dunes, lava flows, playas, Rock land, either alone or in association.
 2. Sierozem, Desert, and Alluvial soils with inclusions of Rock land, Solonetz, Regosol, and Humic Gley; elevations 2,200-6,000 feet; MAP 5-13 inches.
 3. Association of Regosols and Brown soils with inclusions of Alluvial, Chestnut, and Rock land; arid.
 4. Red Desert soils with inclusions of Alluvial, Calcisol, Badlands, Lithosol, Regosol, Rock land, Solonetz, and Solonchak; elevations 125-5,200 feet; MAP 3-12 inches.
 5. Peat.
- W. Mountainous areas; largely forested; climate cool to cold; subhumid to humid. Elevations sea level to over 14,000 feet; multiple use for forestry, grazing, watersheds, and wildlife.
1. Brown Podzolic, Gray Wooded, Brown Forest, Gray-Brown Podzolic soils, Podzols, and Sols Bruns Acides with inclusions of Planosol, Humic Gley, Low-Humic Gley, Lithosol, and Regosol; MAP 16-100 inches; elevations 50-12,000 feet.
 2. Regosols (pumice) with inclusions of Rock land, Lithosol, Alluvial, Humic Gley, Brown Podzolic, and Brown Forest; MAP 15-30 inches; elevation 4,500-7,000 feet.
 3. Brown soils with inclusions of Lithosol and Rock land, shallow, residual over basalt; MAP 10-13 inches; elevation 3,000-4,000 feet; dominated by juniper.

during cool weather when moisture is available, complete seed production, and go summer dormant. Growth starts again in the fall with cool temperatures and good moisture and stops with freezing temperatures. Thus, they are winter active-summer dormant. (2) The principal summer active-winter dormant species are Kentucky bluegrass and the closely related Canada bluegrass.

WINTER ACTIVE-SUMMER DORMANT BLUEGRASSES

BIG BLUEGRASS, *Poa ampla* Merr., is one of several native bluegrasses found throughout the continental climatic areas of the West as a component of the sagebrush-grass and Palouse prairie climax vegetation. It is used on medium-textured Brown, Chestnut, Chernozem, and Prairie soils and on Sierozem soils at elevations of 2,000 to 6,000 feet in zones D-4, D-5, R-2, R-3, and R-4. Typical series are Ritzville; Bannock, Walla Walla, and Tetonia; Athena and Lanark; Palouse and Archabal; and Portneuf and Sagemoor.

Big bluegrass begins growth very early in the spring, as much as 4 weeks earlier than crested wheatgrass. It is leafy and erect and has numerous fine stems, many of which remain vegetative. It is a long-lived perennial bunch grass. Big bluegrass competes with winter annual weeds like cheatgrass and when established and properly managed crowds out cheatgrass. It should be grazed in early spring when growth reaches 8 inches. Livestock should be removed while moisture is still available so the grass can make regrowth before warm summer weather. This is about the time that ungrazed plants are starting to bloom. Regrowth can be grazed after plants turn green in the fall, but a 6-inch stubble should be left.

Livestock graze big bluegrass in the vegetative stage but avoid it when headed. It makes good nutritious hay when grown alone or with Ladak alfalfa.

Cattle showed a higher preference for cured forage of big bluegrass than for six dryland wheatgrasses when the grasses were grown on a Brown soil. Big bluegrass must be protected for 2 years after establishment, or livestock may pull up some plants. This is not a problem on well-established and well-managed fields since volunteer plants establish readily when some seed is allowed to set.

Upland game birds, especially pheasants, choose fields of big bluegrass for nesting sites because the bluegrass has more early spring growth than any dryland grass and the basal leaves provide good shade.

Big bluegrass is a variable species that intergrades into related species *P. nevadensis* Vasey ex Scribn. and *P. juncifolia* Scribn. They differ in seedling vigor, height, leafiness, color, disease resistance, and other characteristics. The big bluegrass ecotype in production, and for which data have been given, was named 'Sherman' (Plate VIA). It is in commercial seed production and is certified. It was selected from a field collection made near Moro in Sherman County, Oreg. On experiment stations and in field tests Sherman proved superior in production to 130 other accessions of big bluegrass.

There are three general big bluegrass types: Sherman which is a general utility type; a dwarf dryland type which rusts severely; and a large blue, hay type which

is more productive than Sherman on Prairie and Alluvial soils but is not as drought tolerant.

Sherman big bluegrass was first in yield of forage among 17 grasses at the dryland experiment station at Tetonia, Idaho, where the elevation is 6,000 feet and MAP is 13 inches. Average production of hay was 2 tons per acre when 50 pounds of nitrogen was applied annually.

At the Moro, Oreg. branch experiment station on Walla Walla silt loam where MAP is just over 11 inches, Sherman big bluegrass produced 1,500 pounds of air-dry forage annually for five crops. This was slightly more than a big bluegrass-alfalfa mixture and more than any other grass alone or in mixture. Root production of a 6-year-old big bluegrass-alfalfa mixture totaled 9,000 pounds per acre in the upper 8 inches and was exceeded only by Whitmar beardless wheatgrass. On a Chernozem soil at Pullman, Wash., big bluegrass grown with alfalfa for 5 years added 8,600 pounds of air-dry roots per acre to the soil in the upper 8 inches. Of this amount 7,200 pounds was grass. Alfalfa grown alone produced only 2,350 pounds of roots per acre. The density of a cubic foot of soil was reduced 20 percent after six hay crops of Sherman big bluegrass on Tetonia silt loam. The field had been used to grow 20 wheat crops, during which time the raw organic matter was reduced from 3.390 percent to 1.730 percent. Big bluegrass restored the organic matter to 3.708 percent.

Establishment of big bluegrass requires special care. The seedling vigor is good for such a small-seeded grass, but seedlings become established only from shallow seedings made during the cool temperatures of late fall, winter, and early spring. Depth regulators that keep the



WN-90349

Figure 11—Sherman big bluegrass provides 1.5 animal-unit months of feed per acre in a range seeding on a Prairie soil.



Plate VIB.
Left to right—
Big bluegrass,
Sherman;
Canby bluegrass,
P-851;
Sandberg bluegrass;
Nevada bluegrass.
Panicles $\times \frac{2}{3}$;
ligules, spikelets,
florets $\times \frac{5}{4}$.

disks from putting the seed more than a half inch into the soil are best. Fall seedings may be broadcast on rough ground after permanent fall moisture is present.

Since seedlings go dormant with high temperatures spring seeding should be made just as soon as it is possible to get on the land.

Seed is produced in 36-inch cultivated rows on non-irrigated Chestnut or Chernozem soils and on irrigated land. Average seed yields with 18 inches of rainfall and 60 pounds of nitrogen per acre are 350 pounds for four seed crops. Under irrigation more than 800 pounds of seed per acre are produced. Seed matures in early July. It shatters readily and should be cut with a binder or windrowed and threshed with a combine. Seed is easily cleaned. Leaf and stem rusts are the most prevalent

diseases in seed fields. Stem maggots may cause 5 percent sterile culms in years of severe infestation. **Sherman** big bluegrass retains a viability of more than 70 percent for 14 years when stored under cool, dry conditions.

Sherman big bluegrass is seeded alone on rangeland and abandoned cropland for early spring grazing. It is also used in mixtures with alfalfa for hay, both on dryland and on well-drained irrigated land where there is a shortage of irrigation water and only one crop of hay is produced (fig. 11).

CANBY BLUEGRASS, *Poa canbyi* (Scribn.) Piper, a vernal-dominant grass, and **SANDBERG BLUEGRASS**, *P. secunda* Presl., (Plate VIB) a very closely related species, are native understory grasses which occur on shallow



Plate VIC.
Bulbous bluegrass,
P-4874.
Plants, panicle $\times 4/5$;
basal bulblet,
ligule, floret $\times 3\frac{1}{2}$.

soils and scabrock areas throughout the sagebrush and wheatgrass rangelands on Sierozem, Brown, Chestnut, and Chernozem soils.

A selection of Canby bluegrass, P-851, from the Blue Mountains of Washington and Oregon has been propagated, tested, and used. It is a vigorous strain. It makes excellent early spring growth, has abundant basal leaves, and numerous culms grow to a height of 18 inches. Canby bluegrass is broadcast in the late fall when other grasses are being seeded. It establishes slowly but volunteers readily when seed shatters. The volunteer plants fill the space between the larger bunch grasses, thus providing erosion control, increasing the early spring forage for sheep and cattle, and effectively preventing invasion of the weedy cheatgrass. Canby blue-

grass uses surface moisture in the early fall, winter, and spring but does not reduce total production of range feed. It goes dormant with the long, warm days of early summer.

NEVADA BLUEGRASS, *Poa nevadensis* Vasey ex Scribn., is closely related to big bluegrass and is common in wet meadows in the intermountain West, although it is not limited to such sites at high elevations (Plate VIB). It is a dominant species in wet meadows that are cut for hay, some of which are medium acid and others moderately alkaline. Nevada bluegrass is more susceptible to yellow stripe rust than big bluegrass. Collections of ecotypes have been made and tested, but none has been equal to Sherman big bluegrass on well-drained soils.

BULBOUS BLUEGRASS, *Poa bulbosa* L., is a small, vernal-dominant bunch grass introduced from Europe. It has become naturalized over extremely wide areas of Brown, Chestnut, and Chernozem soils at elevations under 4,000 feet. It occurs on shallow soils and scabland areas where it is often associated with cheatgrass.

Bulbous bluegrass reproduces by bulblets in the head in place of regular seeds. The base of each culm is also bulbous, and this structure may live for several years in a dormant state. Bulblets are spread in hay by rodents which store the seed, by man, and by domestic livestock. It is a good understory grass for range seedings because it provides excellent ground cover and competes with cheatgrass and other early growing weeds. It provides fall, winter, and spring feed for livestock, principally sheep. It is considered a weed in winter wheat fields.

Bulbous bluegrass makes the most growth in areas where early fall moisture is available. Fall growth stops with freezing weather, but growth starts again in early spring. Plants set "seed" in early June and remain dormant until fall. The seed remains on the plant and is highly nutritious to livestock or wildlife.

Bulbous bluegrass is used as a self-perpetuating cover crop in dryland cherry and apple orchards on Chernozem and Chestnut soils. Its use reduces the soil loss and serious erosion that often occur when orchards on steep slopes are clean cultivated. Bulbous bluegrass is also used below 4,000 feet elevation in range seedings on Brown and Chestnut soils. It should not be planted at higher elevations or near winter wheat areas.

Bulbous bluegrass "seed" is commercially available. One superior strain, P-4874, is in limited production (Plate VIC). It is a good seed- and forage-producing strain and stays green longer than common bulbous bluegrass. Seed production in solid stands with 80 pounds of nitrogen per acre is 500 to 1,000 pounds of clean seed per acre annually for 3 years.

SUMMER ACTIVE-WINTER DORMANT BLUEGRASSES

Two summer active-winter dormant introduced bluegrasses have become naturalized on a wide variety of soils. They are best adapted and most used in cool, semi-humid areas, zones D-1 and D-4, and under irrigation in zone I-1. Other bluegrasses more recently introduced or developed have special conservation uses.

KENTUCKY BLUEGRASS, *Poa pratensis* L., is primarily used for lawns, parks, cemeteries, turf, and golf courses. Agriculturally, it is considered a weedy species in the West; when it invades cultivated pastures, hayfields, or annual cropland through improper management, production drops. However, there are many shallow, non-plowable, and rocky areas where, once Kentucky bluegrass is established, it is no longer economical to replace it with other species. These bluegrass pastures should be managed as conservation plantings, using fertilizer and introducing legumes to get high production.

When used for recreational purposes Kentucky bluegrass is best adapted to Prairie, Brown Forest, and Alluvial soils where MAP is 20 inches or more and to other

soils under irrigation. Bluegrass is only moderately shade tolerant and does best on well-drained nearly neutral soils of limestone origin. On more than medium-acid soil, lime is needed to produce a good turf. Kentucky bluegrass stays green in the summer as long as moisture is available but goes dormant with drought and can stand long summer-dry periods. Plants turn brown and go dormant with freezing temperatures.

Kentucky bluegrass should be seeded alone for recreational purposes. Excellent seedbeds, shallow seeding, fertilizer, and mulching are necessary, followed by irrigation at 3- to 5-day intervals until well established. Seeds germinate slowly, but seed retains its viability well for 5 years or longer under cool, dry storage. For pasture on shallow soils, white Dutch clover is included and phosphate added.

Several named varieties of Kentucky bluegrass are on the market. 'Delta,' 'Troy,' and 'Park' are improved upright varieties somewhat like common bluegrass. 'Newport' is the most abundant seed producer in the West. 'Merion' and 'Cougar' are used for turf; growth is low, and the rhizomes are vigorous. Of the two, 'Cougar' germinates more uniformly and rapidly, is more resistant to mildew and stripe rust, and produces more seed. These varieties are used when intensive management is contemplated.

CANADA BLUEGRASS, *Poa compressa* L., is less widely naturalized in the West than Kentucky bluegrass. It occurs specifically on low-fertility and medium-acid Prairie and Brown Forest soils. Plants are low growing, have flat stems and short leaves, spread by short rhizomes, and are slow to establish. Forage is palatable, but production is low. Canada bluegrass is used when only a low level of management can be practiced.

Canada bluegrass is considered a troublesome weed in zones V-2, V-3, H-1, H-4, and H-7. It is difficult to eradicate and rapidly reinvasades improved pasture seedings unless a high level of management is practiced.

The principal conservation use of Canada bluegrass is for cover and erosion control on roadsides, cuts and fills, borrow pits, damsites, and recreational areas.

UPLAND BLUEGRASS, *Poa glauantha* Gaud., P.I. 109,350, is an introduced bluegrass similar to Canada bluegrass but is darker green, makes a denser sod, and is more resistant to stem and leaf rusts. It is used primarily on roadsides and ditchbanks to provide an attractive and effective ground cover. A variety superior in seed production and rate of growth has been named and registered as 'Draylar.' It has fine stems, is weakly rhizomatous, and is remarkably uniform. Established stands require minimum maintenance.

HYBRID BLUEGRASSES, *Poa* spp. Many hybrid bluegrass types have been developed in cooperation with the Carnegie Institution of Washington. The European summer active-winter dormant species have been crossed with the native American winter active-summer dormant bluegrasses to get grasses with a longer growing season. The rhizomatous species have also been hybridized with the

tufted species to strengthen the root systems of the latter. Some of the new hybrids are promising for recreational and conservation uses, but they are still in trial status.

Group VII. Fine-Leaved Grasses for Cover, Erosion Control, Watershed Structures, and Recreation Areas

The grasses in group VII have an abundant growth of fine leaves that provide effective ground cover. Exceptionally high yields of tough, fine, fibrous roots control erosion and improve soil structure. The abundant basal leaves and tough fibrous roots make a tenacious sod that provides a good bearing surface (fig. 12).

These grasses provide long-lived ground cover on road cuts, fills, and rights-of-way; on the face of water-retention dams; on shoulders and banks of waterways established for flood control; on ski slopes, campsites, picnic areas, trailer parks, and lawns; and on coastal dunes.

These fine-leaved grasses are slow to establish so must be protected with a mulch or seeded with a rapid-developing grass that is also adapted to such sites; fertilizer, especially nitrogen, is required. However, once firmly established, these grasses will retard or prevent the invasion of weeds and brush.

GRASSES OF PRIMARY IMPORTANCE

The grasses of importance in group VII are the fine-leaved fescues. There are two groups: Sheep fescue and red fescue. Hard fescue, an introduction, and Idaho fescue, a native grass, are variations of sheep fescue and are bunch grasses. Chewings fescue, a bunch grass, and red fescue, a sod former, are both red fescues. The sheep fescues are more drought tolerant and better adapted to low fertility sites than the red fescues.

HARD FESCUE, *Festuca ovina* var. *duriuscula* (L.) Koch, is widely adapted to climatic conditions in the intermountain area where MAP exceeds 12 inches. Neither elevation nor frost limits its adaptation. It is similar to native Idaho fescue in climate and soil adaptation.

Hard fescue is adapted to well-drained, medium-acid to mildly alkaline Chestnut, Prairie, Chernozem, Brown Forest, and Brown Podzolic soils. These soils are in zones C-1 to C-4, D-1 to D-4, R-4, R-5, and W-1.

The principal use of hard fescue is for cover for erosion control and for protecting watershed structures and recreation areas. In addition, hard fescue is readily grazed by livestock—especially sheep—and big game in the fall (figs. 13 and 14).

**GREENAR
INTERMEDIATE
WHEATGRASS**



TOPS 5,360
ROOTS 10,090
POUNDS/ACRE

**SHERMAN
BIG BLUEGRASS**



TOPS 3,590
ROOTS 8,190
POUNDS/ACRE

**CRESTED
WHEATGRASS**



TOPS 3,460
ROOTS 7,510
POUNDS/ACRE

HARD FESCUE



TOPS 1,375
ROOTS 19,020
POUNDS/ACRE

**MANCHAR
SMOOTH BROME**



TOPS 1,490
ROOTS 4,740
POUNDS/ACRE

WN-90351

Figure 12—These grasses build soil and produce high amounts of roots per acre.



Plate VIIA.
Hard fescue,
Durar.
Plant $\times 2/5$;
panicle $\times 4/5$;
spikelet, floret $\times 5 1/4$.

Because hard fescue is slow to establish, it is frequently seeded with either slender wheatgrass or crested wheatgrass. Sites where hard fescue is used are usually low in fertility; 20 pounds of nitrogen applied at seeding time and 40 pounds each year thereafter will insure a vigorous stand for effective erosion control.

'Durar' hard fescue was released in 1949 and named and registered in 1963 (Plate VIIA). It was selected from an old planting of unknown origin at a branch experiment station. Durar is moderately tall, densely tufted, semierect, and the plants are uniform. Established plantings are long lived and improve with age. Root production is especially high. It averaged from 5 to 7 tons per acre in the upper 8 inches in 6 years when planted alone on Prairie soils. Alternate-row seedings of

Durar and alfalfa produce 6 tons or more of roots per acre, and about 80 percent are grass roots. The roots are fibrous, fine, and tough. Undecomposed roots are noticeable in the soil for at least 5 years after the field is plowed.

Durar hard fescue produced an average of 400 pounds of seed per acre for 5 years on nonirrigated Prairie soils. Average production on well-drained, irrigated land is 500 pounds per acre. Plantings for seed production are in 36-inch rows and cultivated, and 60 to 80 pounds of nitrogen is applied annually. The seed can be combined when it is in the hard-dough stage but must be dried before storing. Good seed retained a viability of more than 70 percent for 10 years in warehouse storage in cool, dry climates.



BN-29779

Figure 13—Durar hard fescue makes an ideal cover for highway cuts and fills.

RED FESCUES, *Festuca rubra* L., require more moisture than hard or sheep fescues. Otherwise they are widely adapted to zones H-1 to H-6, V-1, and V-2. They make a good turf and have many uses in conservation work. Red fescue is used extensively for erosion control on highway cuts and for protecting channel banks on waterways (fig. 15).

Red fescue is harvested for seed primarily on Reddish-Brown Lateritic, Gray-Brown Podzolic, and Chernozem soils in zones H-2, V-1, and D-4 in Oregon, and more than 4 million pounds of clean seed is produced annually.

The varieties in large-scale production are 'Pennlawn,' 'Rainier,' and 'Illahee.' They are used in lawn mixtures and sometimes alone for fairways on golf courses.

'Clatsop' red fescue is a variety selected from the native vegetation on the coastal dunes of Oregon. It is distinct from other red fescues because it grows during the summer as well as during the cooler seasons. Continued growth during the summer reduces the hazard from wildfires that expose the sand to wind erosion. This makes it especially useful for permanent cover on coastal dunes after the sand has been stilled. Because it is only moderately rhizomatous, it does not become sod bound as quickly as do other varieties of red fescues.

On coastal sand dunes Clatsop red fescue is drilled into stands of European beachgrass after the sand is stilled. Purple beachpea is a good legume to use with the fescue. New seedlings require an application of 300 pounds of 16-20-0 fertilizer. A similar application in later years benefits the stands and improves the density of the ground cover.

CHEWINGS FESCUE, *Festuca rubra* var. *commutata* Gaud., is a bunch grass widely used in mixtures with other grasses for turfs. It makes a good, persistent ground cover on well-drained soils and is shade tolerant. Seed is grown on Reddish-Brown Lateritic soils in zone H-2. In 1963 19,000 acres of chewings fescue grown for seed averaged 400 pounds per acre.

GRASSES OF SECONDARY IMPORTANCE

SHEEP FESCUES, *Festuca ovina* L. and *F. ovina* var. *sulcata* (L.) Koch, have short leaves. They are more drought resistant than the other small-leaved fescues. They are used for bank stabilization along cement-lined irrigation canals and on road cuts and fills on Lithosols and Regosols. Production of tops is low, but ground cover is excellent, root production high, and seed production good.

IDAHO FESCUE, *Festuca idahoensis* Elmer, is a native species widely distributed over the area originally occupied by the Palouse prairie in the intermountain zone of the Pacific Northwest (Plate VIIB). It is highly prized as a range forage for livestock and big game. Plants vary widely in growth form, vigor, color, leafiness, and other characteristics. More than 100 collections have been made and tested. All have one common characteristic: Seed production is scanty since few fertile



WN-90352; WN-90353

Figure 14—Top, Part of an area cleared through forest to lay a gas line. Bottom, Same area 2 years later completely covered with Durar hard fescue.



Plate VIIB.
Idaho fescue,
P-6435.
Plant, panicle $\times \frac{2}{3}$;
spikelet $\times 2$;
floret, caryopsis $\times \frac{4}{3}$.

culms are produced, especially among the more desirable types that are tall, vigorous, and wide leaved. Lack of good seed yields restricts the use of Idaho fescue in conservation work.

BENTGRASSES, *Agrostis* L. spp., are long-lived perennial, fine-textured, creeping turf grasses. Because they produce fine turf, they are used principally for lawns and golf courses. They are the best adapted grasses for most recreational uses in zones V-1 to V-5 and H-1 to H-6 where soil moisture is adequate or where they are irrigated in summer. They also tolerate fine-textured, imperfectly drained, strongly acid soils that are common in these zones. They are of minor value for grazing because the yields are low.

COLONIAL BENTGRASS, *Agrostis tenuis* Sibth., spreads by short surface runners and underground rhizomes. Wide adaptation to soils, low growth, dense sod, and the ability to withstand prolonged winter flooding are primary reasons for their extensive use for soil-stabilization plantings. Colonial bentgrass is frequently included in mixtures for stabilizing grassed waterways, ditchbanks, flood channels, and dikes in zones H-1 to H-7 and V-1 to V-4. 'Astoria' bent is the preferred variety for turf in the West. The 'Highland' variety is more tolerant of droughty, low-fertility sites in zones H-1, H-2, H-4, and H-7 than other varieties. It is more resistant to trampling damage than Astoria.

CREEPING BENTGRASS, *Agrostis palustris* Huds.,



ORE-75291

Figure 15—Annual ryegrass, creeping red fescue, and New Zealand white clover control the bank of flood-control channels. A few scattered plants of tall fescue are shown.

spreads by stolons, is especially moisture tolerant, and provides excellent stabilization at the waterline of drainage channels and irrigation ditches in zones V-1 to V-3 and I-1 at elevations below 3,000 feet. 'Seaside' bentgrass is the preferred variety. It makes an excellent surface for putting greens.

Nearly all domestic bentgrass seed is produced in Oregon where about 25,000 acres of bentgrass seed, mostly colonial, produce 7 million pounds of clean seed annually. Most bentgrasses are grown in solid stands for seed. The seed is cured in windrows, which are picked up with self-propelled combines.

Group VIII. Wet Meadowland Grasses

Wet meadowland grasses (group VIII) grow well on soils with a high water table. They withstand prolonged flooding in the winter and early spring. Established stands are moderately tolerant to summer drought in subhumid zones.

MEADOW FOXTAIL, *Alopecurus pratensis* L., and CREEPING FOXTAIL, *A. arundinaceus* Poir., are similar in origin, adaptation, and use. They are long-lived pasture, silage, and hay grasses adapted to a wide range of poorly drained and strongly acid soils from sea level to high mountain meadows. They are exceptionally frost tolerant, start growth early in the spring, and recover rapidly after cutting or grazing.

The meadow foxtails are used on Humic Gley soils, Planosols, and Ground-Water Podzols. Typical series are Buckley, Cove, Wapato, Caldwell, Clatsop, and Catherine; Dayton and Kooskia; and Whatcom and Edmonds.

The meadow foxtails are used as permanent meadows harvested as hay or silage or grazed as pasture. Mixtures of meadow foxtail and adapted legumes persist for years when they are well managed. These grasses have a more uniform season-long rate of growth during the growing season than most grasses when fertilizers are supplied and ample soil moisture is present. Good yields, as



Plate VIIIA.
 Creeping foxtail,
 P-14762.
 Plant, panicle $\times \frac{2}{3}$;
 spikelet, floret,
 caryopsis $\times 6\frac{1}{2}$.

much as 5 tons per acre, are obtained under these conditions.

A simple mixture using a meadow foxtail and alsike clover is preferred in zones I-1 above 4,000 feet, I-3, I-4, and C-2 to C-4. One with big trefoil and New Zealand white clover is used in zones H-1, H-2, H-4, V-3, and V-4. Timothy can be added in zones V-2, V-3, H-1, and H-4 to reduce the invasion of velvetgrass that is an abundant weedy grass in these zones.

The meadow foxtails have weak seedlings that develop slowly. Firm, moist seedbeds and special care in planting are required. Seeding is done as early in the spring as good seedbeds can be prepared. Because the seed is light and fluffy and has hairy appendages, it is difficult to plant. Planting with precision is easy when 7 pounds

of cracked corn or 3 pounds of rice hulls is mixed with each pound of foxtail seed. Seeding the foxtail and one or more legumes in alternate drill rows is the preferred way of establishing the meadow. On Low-Humic Gley soils an application of complete fertilizer relatively low in nitrogen, such as 40-80-120, has aided establishment of the mixtures.

The meadow foxtails are eaten by all livestock, and good gains are obtained. In one trial where palatability either as hay or pasture for sheep was tested, meadow foxtail was second only to timothy among 20 grasses in the test (Richards and Hawk, 1945). Gains of 600 pounds of beef per acre and yields of 5 tons of hay are reported. A good system for managing meadow foxtail-legume mixtures is to take the first cutting for silage,



WN-90354

Figure 16—This mountain meadow pasture in northern Idaho-Washington area produced 600 pounds of beef per acre when seeded to meadow foxtail and Ladino clover on poorly drained soil.

apply nitrogen fertilizer, and then graze or cut the meadow for hay (fig. 16).

Each of the two species of meadow foxtail contains types that vary widely. A typical plant of creeping meadow foxtail is shown in Plate VIIIA. Obvious differences occur in rate of spread by rhizomes, coarseness of stems and leaves, and color of inflorescence and seed. Cytological investigations show that the basic somatic chromosome number is $2n = 28$, but numerical aberrants with as few as $2n = 27$ to $2n = 46$ occur and male sterile plants have been found. Distinct types, although variable, differ in adaptation and yield when tested in the zones and on the soils where the species are adapted.

The meadow foxtails are self-sterile, hence cross pollinate to produce seed. Named varieties or distinct types must be isolated for certified seed production. 'Garrison' is a named variety of the creeping foxtail. It is well adapted in zone I-1 above 4,000 feet.

All types of meadow foxtail have an indeterminate blooming habit. Seeds shatter easily and within hours after maturity. The seed is harvested when the maximum number of heads are ripe. Seed yields are highest when the crop is bound, shock-cured, and threshed. Yields of 300 to 450 pounds of seed per acre are obtained from row plantings fertilized annually with 60 pounds of nitrogen. Most of the seed harvested in the United States comes from naturalized stands in mountain meadows in southeastern Oregon, where 100 to 300 pounds of seed per acre is harvested. Unprocessed seed retains a viability of more than 70 percent for 10 years when stored in cool, dry climates.

REED CANARYGRASS, *Phalaris arundinacea* L., is a native North American grass which has been domesticated (Plate VIIIB). It is well known for its adaptation to poorly drained Humic Gley, Ground-Water Podzol, Organic (Bog), and Alluvial soils. These soils are interspersed throughout the farmland and grazing areas of

the Northwest. Reed canarygrass tolerates more water during the growing season than any other cultivated grass and withstands short summer droughts. It grows well on irrigated calcareous soils; on fine-textured, wet Solonchak soils; and on brackish tidelands along the coast.

Reed canarygrass is coarse stemmed and broad leaved, is sometimes more than 8 feet tall, and grows in clumps but spreads by short rhizomes. It is highly productive on fertile, wet, flooded, or poorly drained soils. On wet meadows it provides green summer pasture long after upland pastures have dried. On such sites reed canarygrass successfully competes with sedges and rushes.

New seedlings are made on well-prepared seedbeds by shallow, early spring seeding. In wet areas that can be plowed only in late summer—such as in zones I-1 above 4,000 feet, I-3, and I-4—successful seedings are made in late fall so germination does not take place until the following spring. Reed canarygrass should be seeded alone because it is not shade tolerant or compatible in mixtures. Seed germination is slow. Only high-quality fresh seed should be used. Reed canarygrass is also easily established by pressing sod or stems with "joints" into wet soil. This is often called the hay method.

Reed canarygrass is grazed after spring growth reaches 14 inches and the ground is firm enough that trampling does not damage it. In some wet areas a crop of silage or hay may be cut before grazing begins, but the cutting should be made no later than the heading stage and a 4-inch stubble should be left. Proper grazing use requires clipping at least once a year, fencing to confine cattle to fields of canarygrass, and moderate use to prevent overgrazing and thinning of stands. Beef cattle gains on reed canarygrass pasture are good, even though the grass is only moderately palatable. Production varies with length of season and cultural practices and ranges from 250 to 500 animal-unit days per acre.

Because of its coarse vigorous growth, reed canarygrass effectively prevents bank erosion but catches silt. It should be used only in deep gullies and in drainage ditches where the streamflow is rapid. It should not be used in or near shallow drainage channels, small ditches, shallow artificial ponds, or in irrigation canals or laterals.

More than 40 accessions have been tested. There were major differences in production, adaptation to dry and wet sites, and in longevity. 'Superior' is a named variety developed in Oregon. The 'Highland' variety was developed in northern Idaho.

Seed is harvested mostly from old stands. Production from seeded stands averages 250 to 300 pounds per acre. Seed ripens from the tip of the panicle downward. It shatters readily and for this reason is difficult to harvest. Even under ideal cool, dry storage, seed does not stay viable more than 5 years.

TIMOTHY, *Phleum pratense* L., once a widely used classical hay plant, almost disappeared from farms when tractors replaced horses (Plate VIIIC). Recent revival of interest in timothy results from the increased number of riding and race horses used for recreation, primarily in urban areas. Recent recognition of the value of



Plate VIII B.
 Reed canarygrass,
 P-2369.
 Plant $\times 2/5$;
 leaf, panicle $\times 2/3$;
 ligule $\times 5 1/4$;
 floret, caryopsis $\times 10$.

timothy for other uses is the result of new superior varieties.

Timothy is adapted to many soils in the temperate climatic parts of the West where MAP exceeds 20 inches or where the land is irrigated. Its principal value is adaptation to poorly drained Alluvial, Humic Gley, and Brown Podzolic soils. Typical soil series are Puget; Caldwell, Buckley, and Wapato; and Mission and Bonner. Timothy survives a few weeks of flooding during the winter but only a few days in the growing season.

Timothy is grown alone to make premium hay for horse feed but is more often grown with big trefoil on poorly drained soils and with birdsfoot trefoil on imperfectly drained soils in zones H-1, H-2, H-4, V-1, and V-4. A good combination for hay or silage in zones

V-2, V-3, H-1, and H-4 is timothy, meadow foxtail, big trefoil, and New Zealand white clover. Timothy is grown with alfalfa for horse hay on irrigated Alluvial soils.

Another use for timothy is for ground cover on cut-over or burned-over timberland on Reddish-Brown Lateritic, Brown Forest, and Gray-Brown Podzolic soils. These soils occur in zones C-1 to C-3. It is also used on Alluvial soils in zone I-3.

'Drummond' and 'Climax' timothy are two varieties especially well adapted. In addition, they are leafier and mature 10 to 20 days later than common timothy. Drummond is 7 to 10 days later than Climax. Because the varieties are leafy and late, they make high-quality hay or silage when the hay is cut at the optimum stage for the associated legume. Experiment station studies show



Plate VIIC.
Timothy,
Drummond.
Plant $\times \frac{2}{3}$;
ligule $\times 6\frac{1}{2}$;
glumes, floret,
caryopsis $\times 8\frac{1}{2}$.

that Drummond timothy declines less in total digestible nutrients as it approaches maturity than orchardgrass or tall fescue.

Seed yields of timothy average 400 to 500 pounds per acre, and the seed is easy to harvest. Seed retains a viability of more than 70 percent for 5 years in cool, dry warehouse storage.

GRASSES OF SECONDARY IMPORTANCE

REDTOP, *Agrostis alba* L., is widely adapted to wet acid to neutral low-fertility soils. It is often used in mixtures with alsike clover and timothy in zones C-1 to

C-4, D-2, and D-3 for pasture or hay in timbered areas or in short rotations on cultivated land, where MAP is 20 inches or more. It has been used in mixtures for wet waterways, along the waterline of irrigation ditches, in moist burned-over timber areas and to retard invasion of weeds in wet lowlands of new irrigated projects. It is small seeded and requires shallow or broadcast seeding on a prepared seedbed or on bare areas. Redtop grows vigorously and provides a dense, low-growing ground cover but is not as palatable as other wetland grasses. It can stand short summer droughts. Bentgrasses that are not drought resistant are sometimes sold as redtop.

Group IX. Grasses for Dunes and Sandy Land

There are four principal grasses in group IX: Three are dune grasses and one is a drought-tolerant sandy land grass. Two of the dune grasses require maritime climatic conditions, and the third is adapted to dunes in semi-arid climates.

EUROPEAN BEACHGRASS, *Ammophila arenaria* (L.) Link., is naturalized on the Pacific coast where it has been used to control sand dunes since 1896. It has coarse, stiff stems and tough leaves that resist sand blasting. It grows and stools as long as sand is being deposited in the planting. Growth ceases or is weak after the sand is stilled unless nitrogen fertilizer is applied. The common practice is to plant perennial grasses and legumes or adapted shrubs and trees (fig. 17) into stands of European beachgrass after the sand is stilled (see groups VII and X).

European beachgrass is never seeded on active dunes. Instead, it is grown in nurseries to produce strong culms (upright stems). Two-year-old plants are dug and cleaned, the culms are separated, and the tops are cut back to give culms about 20 inches long. Stems that have



ORE-35079. ORE-35079-C

Figure 17—European beachgrass quickly stabilizes sand dunes on the Pacific coast: Top, area before planting; bottom, same area 4 years later.

produced seed heads are discarded.

Cleaned culms are transplanted on the dunes, either manually or by machine. They must be planted 12 inches deep and the sand must be thoroughly compacted around them. The 8 inches of culm above the ground stills the sand. The density of planting required to stop sand movement depends on the severity of the conditions at the site, principally wind velocity and exposure. An average density where maximum wind velocity is 40 miles an hour is 3 culms per hill, spaced 18 inches apart. More culms per hill, closer spacing, or both is required on more severe sites.

European beachgrass is sensitive to high temperatures. Good survival of new transplants is obtained only when maximum air temperature for 72 hours after planting does not exceed 55° F. This is the major factor that determines the planting date. On the Pacific coast this is between November 1 and April 30.

There are four general types of European beachgrass: (1) Tall, coarse, and bunchy; (2) tall, coarse, and creeping; (3) short, fine, and bunchy; and (4) short, fine, and creeping. The most desirable is the tall, coarse, and creeping type. European beachgrass has many phenotypes that differ in rate and amount of tillering. Some increase in number of tillers as little as 13:1 in a year; others increase at a rate of 120:1. The most desirable strain is from the tall, coarse, creeping type that increases at a rate of 40:1. These values were all taken from nursery plantings on stilled sand that received 60 pounds of nitrogen. A selected strain can be maintained easily by nursery planting with culms from the mother plant.

New plantings of European beachgrass on active coastal dunes must be fertilized with 60 pounds of nitrogen, preferably as an ammonium sulfate. The best time is when the buds on the short basal nodes of the culms begin to grow in late winter or early spring.

AMERICAN BEACHGRASS, *Ammophila breviligulata* Fernald, is native to the Atlantic coast and the Great Lakes. It differs from European beachgrass in being strongly rhizomatous, less sensitive to high temperatures immediately after transplanting, and somewhat longer lived. American beachgrass does not grow as vigorously as European beachgrass and therefore does not control sand movement as well under the rigorous conditions along the Pacific coast.

American beachgrass has the general types found in European beachgrass. One tall, coarse, creeping type produced 396 feet of rhizomes in the first season after planting. The best strain of European beachgrass produced only one-tenth as much.

American beachgrass is grown, prepared for planting, and transplanted in the same manner as European beachgrass. Survival after transplanting, however, depends more on the dormancy of the planting stock than on maximum air temperature.

MAMMOTH WILDRIE, *Elymus giganteus* Vahl, is a dual-purpose sand-stilling grass used to control active dunes in the intermountain area of the West. It provides both the initial cover to arrest sand movement and the permanent cover. It is not adapted to coastal climatic



Plate IXA.
Mammoth wildrye,
Volga.
Plant $\times 2/5$;
ligule $\times 4\frac{1}{3}$;
spikelet, floret $\times 3\frac{1}{2}$.

conditions. In the interior it requires MAP of at least 7 inches and deep sands at elevations below 2,000 feet. At higher elevations it will control sand movement and provide a permanent cover on moderately deep and shallow sands. The sand should be fine and contain no gravel but may have a gravel substratum. Examples are Winchester, Quincy, and Moses Lake sands. Mammoth wildrye is both cold hardy and drought tolerant.

Mammoth wildrye varies in growth form from short, slender-stemmed plants to robust plants with strong stems and vigorous rhizomes. A selection from P.I. 108,491 is robust and has stout rhizomes, large flat leaves, and a long dense spike. It was named, released, and registered as 'Volga' mammoth wildrye (Plate IXA).

Volga wildrye is established on inland dunes in the same manner as European beachgrass on coastal dunes. The plants are grown under cultivation on sandy soil and irrigated. Under these conditions, with two applications of 40 pounds each of nitrogen per acre, the increase factor is 15:1. After the culms have been prepared for planting, they are transplanted to the dunes. The usual density is two culms per hill spaced 20 inches apart. Culms can be transplanted at any time after they are dormant in the fall and the sand has moisture to 18 to 24 inches. An application of 40 pounds of nitrogen per acre just as growth begins in late winter or early spring aids in establishment (fig. 18).

Volga wildrye is only moderately palatable to grazing animals and small game, but it is eaten when other feeds

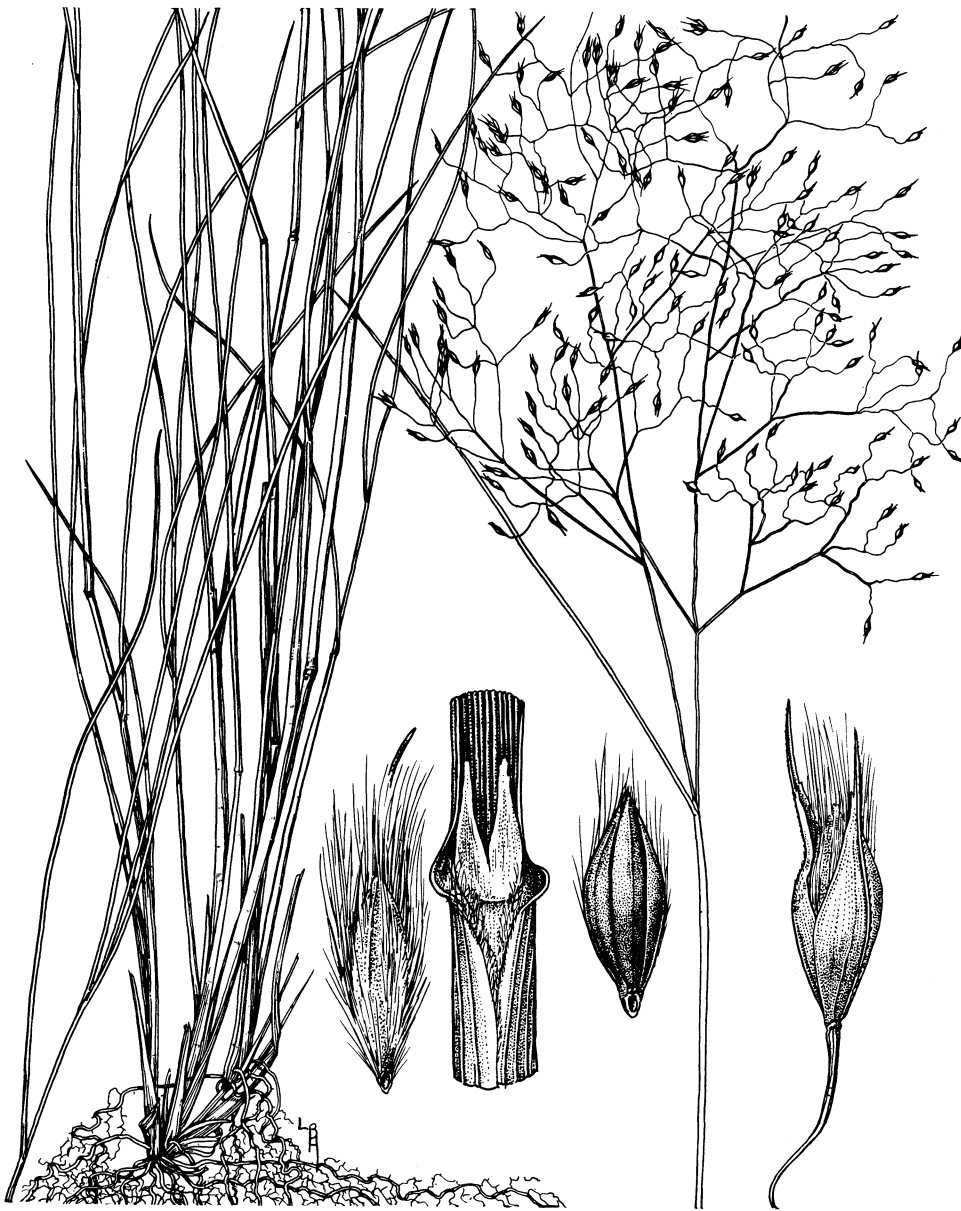


Plate IXB.
Indian ricegrass,
P-2575.
Plant, panicle $\times \frac{2}{3}$;
ligule, spikelet,
caryopsis $\times \frac{5}{4}$.

are not available. Jackrabbits not only eat the new growth but often pull the plants from new plantings. Plantings on active dunes should have livestock excluded for effective erosion control.

Volga wildrye produces good seed. The average yield under irrigation is 300 pounds per acre. Planting-stock nurseries can be established with either culms or seed. Such nurseries produce best on moderately coarse textured soils that are irrigated.

INDIAN RICEGRASS, *Oryzopsis hymenoides* (Roem. and Schult.) Ricker, occurs naturally on coarse-textured soils in arid and semiarid climates throughout the intermountain area of the West. It is most abundant on sandy soils where there is little competition from other perennials.

A good stand on sandy land will control wind erosion. Indian ricegrass is excellent forage both as standing winter hay and for early spring grazing. On Winchester sand in an area where MAP is 8 inches, a volunteer and almost pure stand of Indian ricegrass produced 500 pounds dry matter of usable forage per acre. Seed of Indian ricegrass is relished by livestock and rodents because it is high in protein and fat. Doves eat large quantities of the seed that shatters and lies on the ground. Standing winter hay always contains some seeds in the leaf sheaths (fig. 19).

Indian ricegrass is hard seeded. This has delayed domesticating the grass. Two kinds of dormancy occur, one from heavily indurated lemmas and paleas and one from an impermeable seed coat. Dormancy may persist



WN-90350

Figure 18—Volga wildrye is used to still the sand and provide permanent cover on inland dunes in 7- to 10-inch rainfall areas.



BN-29780

Figure 19—Indian ricegrass, with good culture and management, produces 700 pounds of forage per acre on arid, sandy soils.

for many years, and many studies have been made on how best to break it. An ecotype, P-2575, has been found that has an unusually low percentage of hard seed (Plate IXB). When planted on prepared seedbeds in the fall to a depth of 4 inches, good stands usually result. Planting to this depth has two advantages: It puts the seed in moist soil, which has a stratifying effect, and rodents do not dig the seed as they do in shallow plantings.

The best management for Indian ricegrass is grazing the standing hay in the winter and the young growth in early spring. The livestock must be removed while there is still moisture enough to allow the plants to recover, grow, and produce seed.

Seed of Indian ricegrass is best produced under irrigation on moderately coarse to medium textured soils in 36-inch rows. Nitrogen at 40 pounds per acre, clean cultivation, and moderate irrigation results in yields of 400 to 500 pounds per acre. Because Indian ricegrass has an indeterminate blooming habit seed is harvested when the crop is at peak production. To remove the hairs, threshed seed is processed in a hammermill at speeds not exceeding 500 r.p.m. Seed of Indian ricegrass retains its viability for at least 14 years in cool, dry warehouse storage.

Group X. Legumes

Many legumes are used in conservation work in the West. Some species have been in use many years; others are new introductions. Intensive breeding work with commonly used legumes has resulted in superior varieties; some of them have specific adaptation to soils and climate. Plant material centers have tested new introductions on many sites and determined their adaptation and cultural requirements. Seed supplies of new species and superior varieties are becoming available.

ALFALFA, *Medicago sativa* L., is the most common and most widely used legume for conservation seedings for hay, soil improvement, and wildlife. It is adapted to a wider range of climate and soil than other legumes. Intensive breeding work has extended its range of adaptation and increased its resistance to plant diseases and insects. Mixtures of grasses and alfalfa are grown for hay and for improving soil structure. Even more recent are grass-alfalfa mixtures for pasture.

Alfalfa requires MAP of 16 inches and deep, well-drained soils that are no more than slightly acid or moderately alkaline. On the more acid soils lime is required. Boron and sulfur are often required on soils derived from basalt. Phosphorus improves yield and quality of forage on soils in irrigated areas deficient in this element.

When using grass-alfalfa mixtures some precautions are necessary. For hay, 30 percent of the crop should be grass. More important, a grass should be used that is no more than in the early bloom stage when the alfalfa is ready to cut. Lata orchardgrass and Greenar intermediate wheatgrass (group II) meet this requirement. For pasture, the mixture should be 50 to 60 percent grass by weight.

Grass-alfalfa pastures, especially on irrigated land,

must be carefully grazed to minimize danger from bloat. In early spring some dry roughage should be available, and the alfalfa should be 12 to 14 inches tall. A rotation grazing system should be used, the forage taken quickly, and a minimum regrowth period of 30 days allowed. Highest yields are obtained by using this system.

Only a few of the many varieties of alfalfa are noted here. Agriculture Handbook No. 177, U.S. Dept. of Agriculture, describes 34 varieties, their origin, characteristics, and area of adaptation. The principal varieties of alfalfa for nonirrigated land are 'Du Puits' in zones H-1 to H-6, V-1, and V-2 and 'Ladak' in zones D-1 to D-5, R-4, and R-5. The varieties for irrigated land are in two groups. In the northern part of the intermountain area, 'Ranger' and 'Vernal' are used because they are hardy and resistant to bacterial wilt. In the southern part, 'Lahontan' and 'Talent' are preferred. Lahontan combines resistance to stem nematode, spotted alfalfa aphid, and bacterial wilt. Talent is resistant to stem nematode. Other varieties with either low-set crowns, creeping roots or rhizomes—'Rhizoma,' 'Rambler,' 'Nomad,' and 'Teton'—were developed primarily for grazing.

LADINO CLOVER, *Trifolium repens latum* L., a large, vigorous form of white clover, is widely used in pasture mixtures on irrigated land. Careful management is required to maintain good stands and high production.

Ladino clover has a short tap root, seldom more than 2 feet long. Fleshy stolons formed at the crown creep over the surface of the ground. Roots and upright stems form at the nodes of the stolon, but the roots are short. Because of this growth form, Ladino clover is especially well adapted to shallow soils and is used in place of alfalfa.

Ladino clover is best adapted to soils that are moderately fine textured or medium textured and no more than slightly acid or mildly alkaline. It can be used on moderately coarse textured soils only when intensively irrigated. Annual applications of phosphate fertilizer are needed to get high production.

Light and frequent irrigations are necessary to establish Ladino clover, to keep it in the pasture mixture, and to get good yields. Pasture mixtures are often planted in midsummer after a grain crop. The soil surface must be kept moist until the clover plants have three adult leaves. The effective root zone of a mature Ladino clover plant is not more than 2 feet deep, and the moisture in the root zone must be maintained between 50 percent and field capacity. Irrigating at 5- to 7-day intervals gives the highest yields. A pasture containing Ladino clover must have moist soil when going into the winter. Many stands have been lost when the soil went into the winter dry.

Grazing management for pastures containing Ladino clover should provide a 21-day regrowth period. Shorter intervals reduce yield, and longer intervals cause the grasses to shade out Ladino clover. Using a rotation grazing system with at least four pastures gives desirable results.

The forage in irrigated pastures should not contain more than 40 percent Ladino clover. The percentage of grass can be increased by applying nitrogen. Barnyard

manure is the best source, and it can be applied in late winter or early spring. When commercial forms of nitrogen are used, 20 pounds applied after each grazing cycle produces good results. Commercial nitrogen should not be applied before the first grazing in the spring or after the last grazing in the fall.

Ladino clover is sometimes winterkilled when the pasture goes into the winter dry or there is a sudden drop in temperature in early fall before the plants have hardened off. Annual applications of phosphate fertilizer reduce this hazard.

'Pilgrim' and 'Merit' have been developed for winter hardiness. The most commonly available seed stocks are verified as to origin from California, Idaho, Oregon, or Washington. Average production of seed on irrigated land is 250 pounds per acre.

'NEW ZEALAND' WHITE CLOVER, *Trifolium repens* L., is a vigorous, productive, intermediate type of white clover with more slug resistance than other white clovers including Ladino. New Zealand white clover contains a moderate amount of hydrocyanic acid, which repels slugs. This is of particular value in the V-3 zone where mild temperatures, high humidity, and high rainfall are conducive to large populations of garden slugs. Here slugs have killed Ladino stands in pasture mixtures after 2 years and have greatly reduced pasture yields in some other areas west of the Cascade Mountains.

New Zealand white clover is used in both irrigated and dryland pastures in zones H-1, H-2, H-4, H-5, and V-1 to V-5. It is used in irrigated pastures in zone H-7. It is seeded with orchardgrass on well-drained Alluvial soils (Nehalem) or Gray-Brown Podzolic soils (Willamette), or with Alta fescue or meadow foxtail on poorly drained Low-Humic Gley soils (Brenner), and Humic Gley soils (Wapato and Hebo). Lime to correct soil acidity and annual applications of nitrogen, phosphorus, and potassium are essential for high production from New Zealand white clover-grass mixtures.

Growers of certified seed in New Zealand have taken steps to maintain the proper level of hydrocyanic acid in the variety.

BIRDSFOOT TREFOIL, *Lotus corniculatus* L. is a broad-leaved, moderately deep-rooted, perennial legume well adapted for use as silage or hay on soils too shallow or too poorly drained for alfalfa. It is long lived, giving it a distinct advantage over red clover. Compared with New Zealand white clover, birdsfoot trefoil is 25 percent more productive on nonirrigated soils in zones V-1, V-4, and H-1 to H-6, especially during the summer.

Birdsfoot trefoil is adapted to wide variations of soil reaction, fertility, and moisture. It is used on imperfectly drained or shallow Reddish-Brown Lateritic soils, moderately well drained Sols Lessive, Planosols, and fine-textured Grumusols. Typical soil series are Salkum and Nekia; Gee; Dayton; and Coker, respectively. Birdsfoot trefoil is singularly adapted to Gee soils. Birdsfoot trefoil-Latar orchardgrass mixtures produce 4 tons per acre on deep, well-drained Alluvial and Gray-Brown Podzolic soils, such as the Felida series. Birdsfoot trefoil is tolerant of medium-acid soils, but liming is required

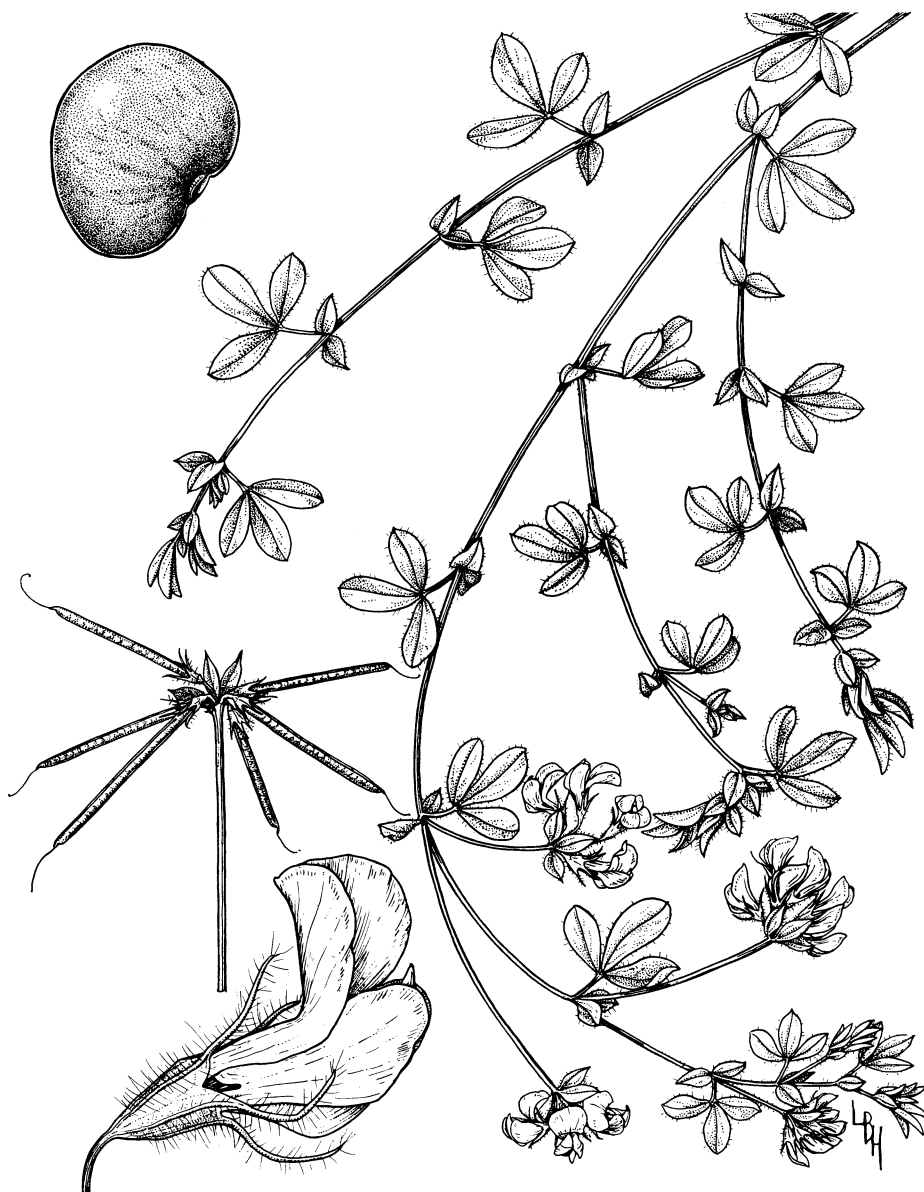


Plate XA.
Birdsfoot trefoil,
Cascade.
Plant $\times 2/5$;
inflorescence $\times 4/5$;
flower $\times 3\frac{1}{2}$;
seed $\times 12\frac{1}{2}$.

on strongly acid soils. Most soils in zones H-1 to H-6, V-1, and V-4—where birdsfoot trefoil is well adapted—are deficient in phosphorus and potassium and require annual applications of these nutrients for high production. Soils in zones I-1 and I-2 are often deficient in phosphorus.

Birdsfoot trefoil is difficult to establish in mixed rows with vigorous grasses, but good stands are consistently established by seeding in alternate rows to reduce seedling competition between the legume and the grass. Birdsfoot trefoil is well suited for use with orchardgrass and is especially compatible with the *Latar* variety. It is also seeded in alternate rows with *Alta fescue* or timothy. Birdsfoot trefoil must be inoculated with cultures especially prepared for this legume.

Alternate-row birdsfoot trefoil-*Latar* orchardgrass plantings have produced more than 3.5 tons of hay per acre on nonirrigated Gee and Salkum soils in zone H-1. Where most dryland grass-legume mixtures produce 85 percent of the season's total by July 1, birdsfoot trefoil-grass mixtures produce only 65 percent by this date.

Two named varieties of birdsfoot trefoil—'*Cascade*' and '*Granger*'—have been developed for use in the West. Both are erect-growing varieties selected from importations from France. *Cascade* was developed cooperatively by the Soil Conservation Service and the Washington Agricultural Experiment Station (Plate XA). *Granger* was developed cooperatively by the Oregon Agricultural Experiment Station and the Agricultural Research Service. Both varieties are well suited for use

as silage and hay, but, because of their erect growth and high palatability, they will not persist in pastures unless rotational grazing is used and a 4-week recovery period allowed. When pastured, a 4-inch stubble should be left for winter. This is especially important in zones I-1 and I-2.

NARROWLEAF TREFOIL, *Lotus tenuis* Wald et Kit. has narrow, linear-lanceolate leaflets. It tends to be more decumbent in growth and is superior to the upright birdsfoot trefoil as a pasture legume. Narrowleaf trefoil is well suited for use on moderately alkaline, fine-textured Grumusols, such as the Coker series in zone H-3. Good stands are consistently established by seeding narrowleaf trefoil in alternate rows with *Alta fescue*.

No named varieties of narrowleaf trefoil are commercially available. Seed stocks of narrowleaf trefoil frequently carry the State of origin, such as Oregon narrowleaf or California narrowleaf. A new variety, 'Los Banos' developed by the Soil Conservation Service in cooperation with the California Agricultural Experiment Station, has given outstanding results in field plantings in zone H-3.

BIG TREFOIL, *Lotus uliginosus* Schkuhr. is particularly well adapted to the poorly drained, strongly acid soils in zone V-3. It is seeded with meadow foxtail for pasture or silage on poorly drained Low-Humic Gley soils, Humic Gley soils, and moist upland Sols Bruns Acides. Typical soil series are Brenner; Hebo and Wapato; and Astoria, respectively. Phosphorus and potash are necessary for good production. Mature plants survive frequent flooding during the winter months. Seedling vigor of big trefoil is only fair, and good stands are obtained only by seeding it in alternate drill rows with grass.

In contrast to birdsfoot trefoil, big trefoil spreads by shallow rhizomes and is well suited for use as a pasture legume. Two distinct varieties of big trefoil have been developed by the Oregon Agricultural Experiment Station: 'Beaver,' a hairy variety with gray-green appearance, and 'Columbia,' a smooth variety with a dark-green appearance. Certified seed of the Beaver variety is available.

Seed production of the trefoils, especially birdsfoot trefoil, is difficult. The seed ripens unevenly, and the pods twist and open during ripening, resulting in loss of seed. Therefore, the crop must be cut when most seed is mature but before excessive seed shattering occurs. Several harvesting techniques are used, including swathing, stacking, baling, and placing the green material on plastic sheeting to dry. Placing the material on plastic has resulted in highest seed yields, but this technique is costly due to the labor involved. Probably the most practical harvesting method for birdsfoot trefoil is to loosely bale the crop soon after swathing and thresh it when the material is cured.

The nonbloating character of the trefoils is especially valuable.

SUBTERRANEAN CLOVER, *Trifolium subterraneum*, L., commonly known as subclover, is an introduced, self-perpetuating winter-annual legume, well adapted for use

in permanent pastures on Brown Podzolic, Reddish-Brown Lateritic, and Noncalcareous Brown soils in zones H-1 to H-6. Typical series are Alderwood, Peavine, and Laughlin, respectively.

Subclover is fall seeded, usually with perennial ryegrass or *Alta fescue*, on a well-prepared seedbed. Establishment is sometimes difficult, and production is generally low on soils that are strongly acid (pH 5.5 or below) unless lime is applied. Establishment has been successful at greatly reduced cost on acid soils by mixing lime and superphosphate with inoculated seed.

On land too steep for seedbed preparation, subclover has been established in native vegetation by a pasture renovator or sod seeder. This method requires removing the competition by heavy grazing before seeding and placing inoculated seed above banded fertilizer. Annual applications of 40 pounds of available nitrogen, 70 pounds of available phosphorus, and 30 pounds of sulfur per acre have increased production of subclover-grass pastures from 1 animal-unit month of grazing per acre to as much as 6 animal-unit months on Laughlin soils.

Subclover-grass stands are ready for full use the second winter. Climate and fertility level determine the amount of winter grazing; the greatest production occurs during March, April, and May. Subclover will tolerate continuous close grazing, but rotational grazing with short periods of heavy use will increase subclover-grass yields by at least 20 percent and will help maintain the perennial grass.

'Tallarook,' a late-maturing variety, is used in zones H-1 and H-4 where longer growing seasons occur. 'Mt. Barker' and 'Nangeela,' medium-late varieties, are more reliable in areas of lower rainfall or on shallow, droughty soils in zones H-2, H-3, H-5, and H-6.

Seed harvest is a problem. Subclover is unique among clovers in that the ripening heads produced on prostrate stems turn downward and many heads become buried. To harvest the seed it is necessary to lift the mat of clover vines and cut below the seed heads. A lespedeza cutter bar works well. In especially dense stands, pea lifter guards are used. Regardless of the cutting equipment used, many seed heads remain on the soil surface after harvest. Vacuum harvesters have been successful in salvaging burs left by harvesting with conventional equipment.

'LANA' WOOLYPOD VETCH, *Vicia dasycarpa* Ten., is a reliable, self-perpetuating winter-annual legume, particularly valuable for improving annual range and dryland pasture in zones H-3, H-5, and H-6. It is easy to establish and consistently produces high forage when properly managed. In addition to providing high-quality forage and extending the green-feed period beyond that of most annual grasses, Lana vetch seed is a preferred food for upland game birds, especially doves.

Excellent stands are obtained on a wide range of soils, including Reddish-Brown Lateritic, Noncalcareous Brown soils, and Grumusols. Typical series are Josephine, Laughlin, and Coker, respectively (fig. 20).

Annual applications of 60 to 70 pounds of available phosphorus per acre triples production of Lana vetch and greatly improves the quality of forage of southwestern Oregon range and nonirrigated pasture land, including



ORE-75305

Figure 20—Lana vetch, a reseeding annual legume, is easily established and increases forage yield on hill land.

those areas now invaded by medusahead wildrye, *Elymus caput-medusae*, and hedgehog dogtailgrass, *Cynosurus echinatus*. Seeding Lana vetch on Grumusols in zone H-3 effectively suppresses medusahead wildrye. Dense, vigorous stands of Lana vetch reduce the amount of medusahead wildrye and increase its utilization by cattle.

Lana vetch can be seeded in the fall with a pasture renovator or sod seeder directly into annual grass residue. Better stands are assured and less seed is required by drill seeding on roughly prepared seedbeds. Lana vetch can also be seeded alone or in mixtures with annual ryegrass or tall oatgrass. During the establishment year, grazing must be deferred until the vetch has matured seed. Thereafter, Lana vetch is pastured during March and April and after the seed matures in early July. Or it can be pastured entirely for late feed. The dry forage of Lana vetch is palatable, retains its nutrient content well, and is a valuable supplement to dry annual grasses.

Lana vetch is entirely self-fertile. It should not be planted close to areas producing commercial seed of hairy or common vetch due to the danger of animal, bird, or mechanical contamination.

WHITE SWEETCLOVER, *Melilotus alba* Desv. and **YELLOW SWEETCLOVER**, *M. officinalis* (L.) Lam. are important cultivated legumes used for soil conservation. They are well adapted under irrigation or where MAP is 17 inches or higher and soils are only slightly acid to moderately alkaline. Zones of adaptation are C-1, C-2, C-4, D-1 to D-4, I-1, and I-2. Within these zones the great soil groups and soil series, respectively, to which sweetclover is best adapted on dryland are Brown Forest (Spring-

dale); Prairie (Palouse); and Chernozem (Athena); and under irrigation Brown, Chestnut, Sierozem, and Alluvial soils (all soil series).

There are both biennial and annual varieties used for pasture and green manure in short rotations. 'Madrid,' a biennial yellow-blossom variety, and 'Spanish' and 'Evergreen,' biennial white-blossom varieties, are preferred. Generally, the yellow-blossom varieties stand more drought, flower earlier and are preferred for grazing. The late white-blossom varieties are more productive and are used for green manure. Annual varieties are used in irrigated areas where the growing season is long.

Sweetclover acreage has declined in the past decade because of heavy use of nitrogen on grain crops undersown with sweetclover, infestations of the sweetclover weevil, and universal use of herbicides—to which sweetclover is very sensitive. When sweetclover is established with peas as a companion crop, the peas are generally dusted for pea weevil control. Sweetclover weevil is killed, and stands are excellent.

Sweetclover is also established with barley in alternate rows, and timely weevil control makes successful stands possible. When planted primarily for pasture, a rapid-developing grass is included and no companion crop. More than 200 pounds of beef per acre has been produced on second-year sweetclover-grass mixtures.

Sweetclover is plowed rough in late summer after pas-



IDA-45357

Figure 21—Cicar milkvetch, a vigorous nonbloating legume, is used for pasture and for erosion control on Chernozem, Prairie, and Brown Forest soils.

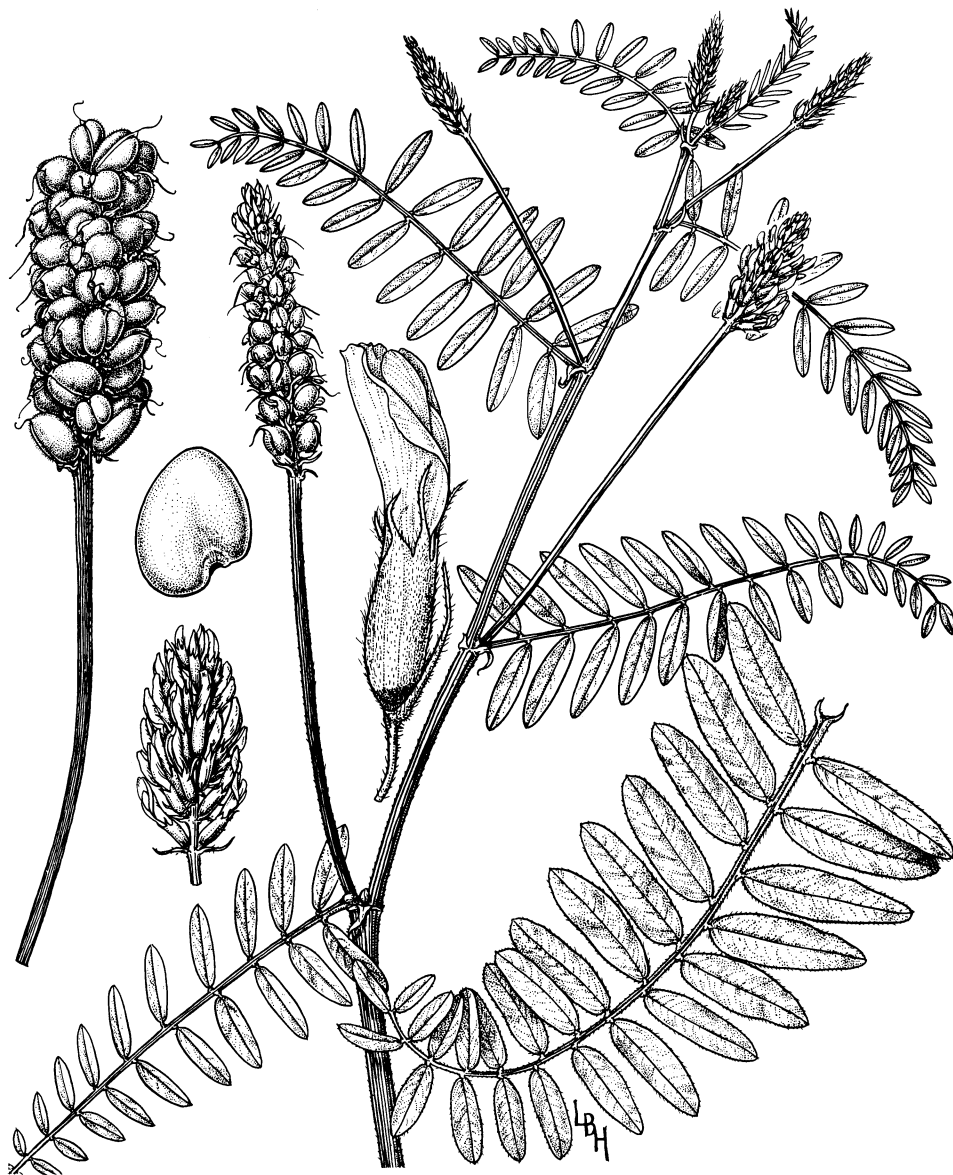


Plate XB.
Cicer milkvetch,
Cicar.
Plant $\times 2/5$;
raceme $\times 2/3$;
flower $\times 3$;
seed $\times 6\frac{1}{2}$.

turing. When it is grown primarily for green manure, the plowing date is adjusted to the growth stage of the sweet-clover and the moisture left in the soil. Rough plowing of sweetclover gives good erosion control.

RED CLOVER, *Trifolium pratense* L., is an important conservation legume. It requires MAP of 20 inches or irrigation. It is well adapted to cutover timberlands and moderately acid soils in zones C-1 to C-4, D-1 to D-3, H-1 to H-6, and V-1 to V-3 and is grown on Humic Gley, Brown Podzolic, Gray-Brown Podzolic soils, Planosols, and Reddish-Brown Lateritic soils where alfalfa is not well adapted or where a short-lived legume is needed. Typical soil series are Caldwell; Helmer; Larkin and Freeman; Santa (now Sols Bruns Acides with fragipan); and Hood, Olympic, and Salkum. Regarded as a

short-lived perennial, red clover is best managed as a biennial and used with rapid-developing grasses in hay, pasture, and green-manure mixtures.

New varieties are brought to the Northwest for seed increase because seed production averages 200 to 300 pounds per acre, several times that in other parts of the United States. Improved varieties are all double-cut strains and have resistance to one or more of the common diseases: Anthracnose, crown rot, or mildew. 'Kenland' is the most widely grown improved variety. Others are 'Pennscott,' 'Dollard,' and 'Lakeland.' All are well adapted to conservation use in the Northwest.

'CICAR' CICER MILKVETCH, *Astragalus cicer* L., P.I. 66,515 is a long-lived, perennial, sod-forming legume with leafy, semiprostrate, succulent stems (Plate XB). In



Plate XC.
Flat pea.
Plant $\times \frac{2}{3}$;
pods $\times \frac{2}{3}$;
seed $\times 4\frac{1}{3}$.

zones D-1, I-1 above 4,000 feet, R-4, and R-5, Cicar milkvetch is superior to alfalfa in longevity of stand and in yield. It is adapted to Chernozem, Brown Forest, Brown Podzolic, and Gray-Brown Podzolic soils where MAP is 14 inches or more. It is especially well adapted to soils derived from limestone. Cicar milkvetch is more persistent and higher in production than alfalfa on subirrigated or irrigated slightly acid to moderately alkaline Alluvial soils and Regosols where there is a high water table.

Cicar milkvetch is used in place of alfalfa in grass-legume mixtures for erosion control, hay, or pasture at high elevations where alfalfa commonly freezes back or is restricted in growth by shallow soils. It does not begin growth as early in the spring as alfalfa and it blooms later. It recovers rapidly after it is cut or grazed, remains green

and retains its leaves in the summer, and is remarkably free of diseases and insects. It is palatable to livestock and big game. Precise tests with laboratory animals show that this species has no toxic alkaloids. This was confirmed by feeding both fresh and cured forage to livestock (fig. 21).

Some care is required to establish Cicar milkvetch. The seed germinates slowly, and young seedlings can be crowded out by other plants. When grown with an adapted perennial grass, alternate-row seedings result in good stands of both the grass and the legume. Cicar milkvetch requires a specific inoculant, and it is commercially available. Milkvetch plants should not be grazed until firmly established. This usually requires 2 years, during which time hay crops can be taken. Once established, Cicar milkvetch is remarkably persistent; in fact, an old



Plate XD.
Purple beachpea,
P-4139.
Plant $\times \frac{2}{3}$;
pods $\times \frac{2}{3}$;
seed $\times \frac{4}{3}$.

stand is somewhat difficult to eradicate. This suggests growing it where permanent seedings are needed.

Seed of *Cicar milkvetch* is grown either on irrigated land or on Chernozem or Prairie soils. Production averages 400 pounds per acre in cultivated rows. The seedpods hold well and do not split open. The crop is cut, swathed to dry, and threshed. Because hard seed content is high, scarification before planting is required. When stored under cool, dry conditions for 14 years, germination increased from 11 percent to 67 percent, and the percentage of hard seeds dropped from 75 to 13.

SAINFOIN, *Onobrychis viciaefolia* Scop., is a tall, leafy, herbaceous legume that has promise for use in legume-grass mixtures in zones D-1, D-3, R-4, R-5, and I-1 above

4,000 feet. It is frost tolerant and drought resistant and recovers early in both spring and fall. Sainfoin is more compatible in mixtures with bunch grasses than with sod grasses. It is palatable to livestock and big game, not known to cause bloat, and equal to alfalfa in feed quality. The leaves of sainfoin do not shatter as quickly as those of alfalfa, especially at haying time. The flowers are attractive to bees. Sainfoin is a good seed producer, and the seeds germinate quickly even on the surface of moist soil when the pods drop.

A selection from P.I. 108,938, named 'Onar,' has been released. It is remarkably free from insect pests and most plant diseases, but crown rot may occur. It is adapted to zones D-1 and I-1 in the Upper Snake River Basin.

BRAMBLE VETCH, *Vicia tenuifolia* Roth., is a perennial, sod-forming legume of European origin. It is well adapted for both conservation and wildlife use on Brown Podzolic and Brown Forest soils.

Like common vetch, it has narrow smooth leaves and fine stems, but it grows more rigid and does not lodge as readily. It grows 3 feet high and has profuse purple blooms from June 15 to July 15. Its seeds are smaller than those of common vetch and mature over a long period. Like other vetches, it shatters readily.

The strain P-692 in production at Pullman, Wash., is a selection from P.I. 107,128. It is vigorous and productive. Seed matures early, but the vines stay green into late summer. It produces 150 to 300 pounds of seed per acre and must be cut by windrowing when seeds first begin to shatter. Seeds are hard and must be scarified and inoculated before planting. Plants are slow to establish, reaching maturity in the third year. Stands are most successfully established by seeding alone and providing weed control and protection for at least 1 year. These stands make a dense erosion-control cover by the third season. This strain has been used on cutover and burned-over timber areas in zones C-1 to C-4, and for cover on road cuts and fills. It also has a potential for wildlife food and cover.

FLAT PEA, *Lathyrus sylvestris* L., is a long-lived, rhizomatous legume introduced from central Europe (Plate XC). Its primary conservation use has been for erosion control and forage on cutover and burned-over Brown Podzolic and Reddish-Brown Lateritic soils in zone H-4. Typical series are Alderwood and Olympic, respectively. Flat pea is also of conservation value for stabilizing road cuts and barren (critical) areas. Its erosion-control uses, high-forage production, and palatability in late summer are outstanding features.

Seedlings started in flats and transplanted to the field have given better stands and faster establishment than direct seedings. On small areas plants spaced 6 feet apart

(1,210 plants per acre) soon provide an excellent stand. With superphosphate applications at the time of seeding or transplanting, established plants quickly form a dense growth, providing excellent erosion control and sufficient competition to retard the invasion of ferns and brush. Flat pea has produced more than 5 tons of dry matter per acre on Whatcom silt loam in zone H-4.

Flat pea becomes more palatable to livestock as the plant reaches maturity. It can be used to provide high protein forage late in the summer when grasses are usually dry. Reports from Europe are that flat pea seeds—and to a lesser degree its vegetation—are toxic to certain classes of livestock. This has not been substantiated in the West.

The use of flat pea is restricted in areas adjacent to commercial pea production because it is a host for the pea moth.

PURPLE BEACHPEA, *Lathyrus japonicus* Willd. (*maritimus* Bigel.) is a slow-developing, long-lived legume that spreads by rhizomes (Plate XD). It is native to the coasts of Oregon and Washington. Purple beachpea is used in the grass-legume mixture seeded into the sand-stilling grasses for permanent cover on coastal dunes in zone V-3. No other legume is better adapted to this use than purple beachpea, but the young seedlings do not reach maximum development until the third and fourth years.

The most successful mixture for dune stabilization is purple beachpea 20 pounds, hairy vetch 30 pounds, common ryegrass 6 pounds, and creeping red fescue 4 pounds per acre. The mixture is seeded in early spring and fertilized with 150 to 200 pounds of 16-20-0. The ryegrass and vetch are used in the mixture to provide cover and nitrogen until the slow-growing beachpea and the creeping red fescue are established.

The demand for purple beachpea has not been adequate to encourage commercial production. Seed must be collected by hand from stands along the northern coast. Seed collection is costly, and pea moth infestation sometimes reduces seed yield.

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Appendix

TABLE 1.—Average seed characteristics and standards for some grasses and legumes

Common name	Scientific name	Variety	Seeds per pound	Seeds per square foot at 1 pound per acre ¹	Seed quality standards	
					Purity	Germination
			<i>Thousands</i>	<i>Number</i>	<i>Percent</i>	<i>Percent</i>
beachgrass						
American*	<i>Ammophila breviligulata</i>					
European*	<i>Ammophila arenaria</i>					
bentgrass						
colonial	<i>Agrostis tenuis</i>	Astoria, Highland	8,500	195	95	85
creeping	<i>Agrostis palustris</i>	Seaside	7,800	180	95	85
redtop	<i>Agrostis alba</i>	—	5,000	120	90	85
bluegrass						
alkali	<i>Poa juncifolia</i>	—	1,000	23	85	65
big	<i>Poa ampla</i>	Sherman	917	21	90	70
bulbous	<i>Poa bulbosa</i>	P-4874 ²	450	10	95	85
Canada	<i>Poa compressa</i>	—	2,500	57	90	75
Canby	<i>Poa canbyi</i>	P-851	926	21	95	75
glaucantha upland	<i>Poa glaucantha</i>	Draylar	2,500	60	90	75
Kentucky	<i>Poa pratensis</i>	—	2,156	50	90	75
Nevada	<i>Poa nevadensis</i>	—	1,082	25	85	65
Sandberg	<i>Poa secunda</i>	—	925	21	90	65
brome						
Alaska	<i>Bromus sitchensis</i>	—	59	1.4	95	85
meadow	<i>Bromus biebersteinii</i>	Regar	80	1.8	95	85
meadow	<i>Bromus erectus</i>	—	71	1.6	95	85
meadow	<i>Bromus riparius</i>	—	71	1.6	95	85
mountain	<i>Bromus marginatus</i>	Bromar	90	1.6	90	85
rescue	<i>Bromus catharticus</i>	—	62	1.4	95	85
Russian	<i>Bromus tomentellus</i>	—	112	2.5	92	85
smooth	<i>Bromus inermis</i>	Manchar	125	2.9	92	85
canarygrass						
reed	<i>Phalaris arundinacea</i>	—	506	12	96	80
fescue						
chewings	<i>Festuca rubra commutata</i>	—	615	14	98	80
hard	<i>Festuca ovina duriuscula</i>	Durar	565	13	95	85
Idaho	<i>Festuca idahoensis</i>	—	450	10	90	80
red	<i>Festuca rubra</i>	Clatsop	615	14	98	80
sheep	<i>Festuca ovina</i>	P-274	680	16	95	80
tall	<i>Festuca arundinacea</i>	Alta	230	5.3	98	85
tall	<i>Festuca arundinacea</i>	Goar	181	4.3	98	85
foxtail						
creeping	<i>Alopecurus arundinaceus</i>	Garrison	900	21	80	80
meadow	<i>Alopecurus pratensis</i>	—	900	21	80	80
hardinggrass	<i>Phalaris tuberosa stenoptera</i>	—	347	8.0	96	75
oatgrass						
tall	<i>Arrhenatherum elatius</i>	Tualatin	150	3.5	90	70
orchardgrass	<i>Dactylis glomerata</i>	Latar, Pomar	540	12	90	80
ricegrass						
Indian	<i>Oryzopsis hymenoides</i>	P-2575	235	5.4	95	11
ryegrass						
Italian	<i>Lolium multiflorum</i>	—	217	5.0	95	90
perennial	<i>Lolium perenne</i>	—	247	5.7	98	90
sacaton						
alkali	<i>Sporobolus airoides</i>	—	1,750	40	98	80
timothy	<i>Phleum pratense</i>	Climax, Drummond	1,300	30	97	80

TABLE 1.—Average seed characteristics and standards for some grasses and legumes—Continued

Common name	Scientific name	Variety	Seeds per pound	Seeds per square foot at 1 pound per acre ¹	Seed quality standards	
					Purity	Germination
			<i>Thousands</i>	<i>Number</i>	<i>Percent</i>	<i>Percent</i>
wheatgrass	<i>Agropyron subsecundum</i>	—	150	3.5	95	95
bearded	<i>Agropyron spicatum</i>	P-739	140	3.2	90	85
bluebunch	<i>Agropyron inerme</i>	Whitmar	135	3.0	90	85
beardless	<i>Agropyron cristatum</i>	Fairway	200	4.6	95	85
crested	<i>Agropyron desertorum</i>	Nordan	175	4.0	95	85
crested, standard	<i>Agropyron intermedium</i>	Greenar	100	2.4	95	85
intermediate	<i>Agropyron intermedium</i>	P-14	115	2.7	90	90
intermediate (dwarf)	<i>Agropyron trichophorum</i>	Topar, Luna	91	2.0	90	85
pubescent	<i>Agropyron sibiricum</i>	P-27	250	5.7	95	85
Siberian	<i>Agropyron trachycaulum</i>	Primar	160	3.7	90	85
slender	<i>Agropyron riparium</i>	Sodar	170	3.9	90	80
streambank	<i>Agropyron elongatum</i>	Alkar, Largo	79	1.8	95	85
tall	<i>Agropyron dasystachyum</i>	P-1822	156	3.6	85	88
thickspike	<i>Agropyron smithii</i>	—	110	2.5	85	60
western						
wildrye						
basin	<i>Elymus cinereus</i>	P-5797	165	3.8	80	85
blue	<i>Elymus glaucus</i>	—	131	3.1	80	85
mammoth	<i>Elymus giganteus</i>	Volga	55	1.3	80	85
Russian	<i>Elymus junceus</i>	Vinall	170	3.9	90	80
alfalfa	<i>Medicago sativa</i>	—	225	5.2	99	85
clover						
alsike	<i>Trifolium hybridum</i>	—	682	16	96	90
Ladino	<i>Trifolium repens latum</i>	—	800	18	99	95
red	<i>Trifolium pratense</i>	—	281	6.5	96	90
subterranean	<i>Trifolium subterraneum</i>	Mt. Barker	75	1.7	99	90
subterranean	<i>Trifolium subterraneum</i>	Nangeela	60	1.4	97	80
subterranean	<i>Trifolium subterraneum</i>	Tallarook	52	1.2	99	90
white	<i>Trifolium repens</i>	New Zealand	800	18	99	85
pea						
beachpea, purple	<i>Lathyrus japonicus</i>	—	12	0.28	98	90
	(<i>maritimus</i>)					
flat	<i>Lathyrus sylvestris</i>	—	15	0.34	98	93
milkvetch						
cicer	<i>Astragalus cicer</i>	Cicar	145	3.3	95	75
sainfoin	<i>Onobrychis viciaefolia</i>	Onar	18	0.41	90	75
sweetclover	<i>Melilotus alba</i>	—	262	6	99	85
trefoil						
big	<i>Lotus uliginosus</i>	Beaver	1,000	23	98	85
birdsfoot	<i>Lotus corniculatus</i>	Cascade	470	11	98	85
narrowleaf	<i>Lotus tenuis</i>	Los Banos	485	11	98	85
vetch						
bramble	<i>Vicia tenuifolia</i>	P-692	33	0.75	90	90
woollypod	<i>Vicia dasycarpa</i>	Lana	11	0.25	90	90

*Culms, not seeds, are used. See text.

¹Rate of seeding per acre varies widely in the area. Standard rates are available in technical guides in SCS offices and in other Federal and State agricultural offices.²P—numbers are accession numbers assigned by SCS plant materials centers.

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¹ Varieties developed in SCS plant materials centers are shown in boldface.

² Boldface page numbers indicate detailed drawings of plants.

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